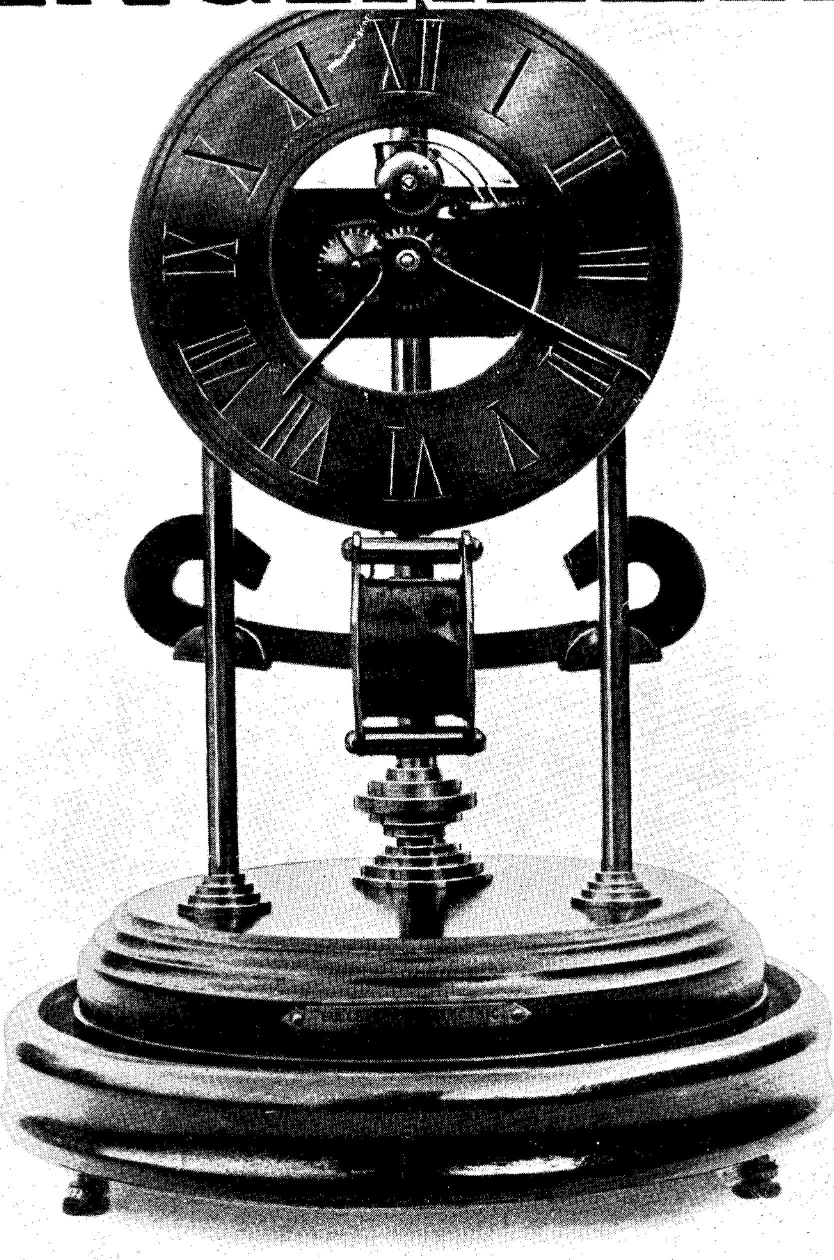
THE MODEL ENGINEER

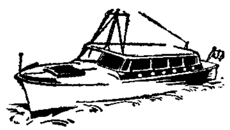


Vol. 97 No. 2407 THURSDAY JULY 10 1947 9d.

The MODEL ENGINEER

Percival Marshall & Co. Ltd., 23, Great Queen St., London, W.C.2

10 JULY 1947



VOL. 97. NO. 2407

SMOKE RINGS

Our Cover Picture

THIS week we show a Bullé type electric clock, the work of Mr. Reginald N. Gibbs, who writes :—" Some time ago I had the opportunity of repairing a Bullé electric clock. The principle and escapement so intrigued me that I decided to tackle the construction of one for myself. Apart from the dimensions, the only difference between a standard Bullé clock and my own is in the magnet system, in which I have incorporated two " Eclipse " magnets, with like poles adjoining a mild-steel centre bar. The pendulum coil has 6,600 turns of 41 s.w.g. enamelled wire with a resistance of 1,100 ohms. The pendulum receives an impulse every swing, and, on the return swing is reputed to give a little back to the battery. A milliammeter incorporated in the circuit shows that the current demand is $1\frac{1}{4}$ milliamps, the needle also drops below zero. The clock has been running about three months on a $1\frac{1}{2}$-volt dry cell concealed in the base. The pillar supporting the pendulum suspension is connected to one pole of the battery, the other pole of the battery being connected to either of the two front pillars which support the clock works. The pendulum is $\frac{1}{4}$ second, $5\frac{1}{2}$ in. from the suspension to the centre of gravity of the bob and coil. A silver pin on the pendulum engages a small trigger switch which has a silver contact on one side and a dielectric on the other side. This trigger switch is on a common shaft with the escapement, which, in turn, drives a 60-tooth wheel having a worm on its spindle driving an 80-tooth wheel on the main shaft and then, of course, the usual 12 to 1 reduction for the hour hand. The photograph ably taken by my friend, Mr. F. Lapworth, brings out the details of the escapement, but we were sorry that we could not get a satisfactory photograph with the glass dome on, owing to light reflections. I made my first electric clock from a series of articles which you published in 1920, keeping pace with each instalment. My wife and I thought the resulting timepiece was rather noisy, as we were then in a little cottage, so I experimented to reduce the noise with such success that I was asked to put the tick back again. Since then I have made nearly a dozen clocks, each more successful than the last."

" Simpson's Day "

MAJOR T. W. LAWSON writes :—" I would like to see placed on record the revival of the above popular event. Before the war, as a lot of your readers know, Mr. Simpson of Brentwood who had made a remarkable portable multi-gauge track, took it upon himself to disrupt the layout of one of his laundries in order to lay down this track, *in the laundry*, for the benefit of loco. enthusiasts, who could thus have one good track day a year under cover and continuous. This event became known as " Simpson's Day " and it became a real gathering of the clans. Many well-known locos. and their builders have chased each other round and round amongst all that machinery to the delight of those who were onlookers, amongst whom could always be seen the late Mr. A. W. Marshall, Mr. Ferriera and others.

Driver Irvin was always there with his lovely and lively $3\frac{1}{2}$ in. G.N. Atlantic, frightening the life out of the spectators by his spectacular runs. The London Society turned out in force with their powerful loco. and altogether it was a glorious day, crowned by the extreme hospitality of Mr. and Mrs. Simpson and family. Who can forget those teas and the restfulness of sitting in the evening listening to J. N. Maskelyne giving a masterly rendering of some classic on the piano? Happy days! I have often thought of and recounted those days, when serving in foreign climes and wondered if ever I would see their return. This year saw my wishes fulfilled and once more "Simpson's Day" came round. For various reasons it could not be held in the laundry but the track was erected in the sports ground at Brentwood and "Simpson's Day" was a try out for a charitable fete which was to be held on Whit Monday. Perhaps owing to the transport difficulties, or to it not being widely known, the enthusiasts were not there *en masse* as in previous years. Nevertheless those who were there had a grand day. The weather was what the doctor ordered. Mr. Simpson, despite his seventy odd years was in good form and going round in his quiet efficient manner seeing to everybody's wants, his two sons, now both men, giving him able support. Eight locos. were on show—the Society's 0-6-0 goods in the able hands of Mr. Maxwell, Mr. Clarke of Romford with his 4-6-0 L.N.E.R. 1 in. scale, Mr. J. Wood-Mason and his lovely $3\frac{1}{2}$ in. *Lord Nelson*, Mr. Bert Randall, always there with his $3\frac{1}{2}$ in. L.N.E.R. Pacific, a $2\frac{1}{2}$ in. Dyak whose owner I did not know, Mr. Maxwell's lovely G.W.R. 0-6-0 goods and its builder Mr. Frank Baldwin, still in his youth, who tells me he is building another of this same class. Last but by no means least, the old war horse Uncle Jim Crebbin had both *James Milne* and *Felix Pole* there. Had he not the former, I would have sent him home for it, for Simpson's day would have been incomplete without it. About the running of the locos I will say little, except that with 'Milne' I felt quite an improvement owing to some experiment in smokebox design and valve setting which Mr. Crebbin has been carrying out. All who know the locos mentioned will know that they put up a good show and that we had a real good time. I took two of the Norwich Society and my own son with me and we returned to Norwich that night all feeling that it had been a very well worth while journey. Thanks Mr. Simpson, may the "Day" carry on and perhaps next year we will see all the old hands roll up with their steeds—they will enjoy this happy revival."

Model Engineering in Bombay

A FEW weeks ago, I quoted from a very pleasing letter I had received from Mr. M. P. Polson, chairman of the Bombay Society of Model Engineers, generously offering a cup to be completed for at THE MODEL ENGINEER Exhibition. Since then, Mr. Polson has sent some details of the fourth Annual Exhibition, held recently by the B.S.M.E., at St. Xavier's Hall, Dhobi Talas, Bombay. These premises are larger than the Conference Hall at Electric House, Colaba, previously used, but were necessary because the number of entries had grown to no fewer than 350. There can be no question but that the model engineering interest is very much alive in Bombay; not only that, it is commendably varied. The Exhibition was divided into seven main sections covering respectively, Railways, Shipbuilding, Mechanical Engineering, Meccano, Fretwork, Carpentry and Aircraft, to which was added, for the first time, a Loan Section, displaying models lent by commercial undertakings. All this speaks well for the energy and enterprise of the members; for the B.M.S.E. was founded as recently at 1942, and has made astonishing progress since then. It possesses a well equipped workshop and is fortunate in being able to number amongst its members experts in the use of workshop equipment, skilled model makers and other exponents of handicrafts, all able and willing to help the novitiates among their fellow-members.

To Promoters of Miniature Railways

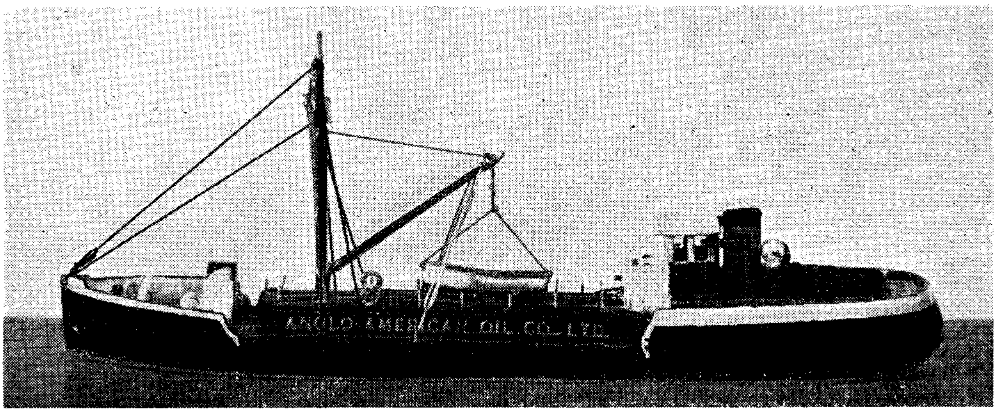
MR. J. N. MASKELYNE, while expressing his interest and pleasure in the rapidly-growing number of miniature railways of $7\frac{1}{4}$-in. gauge, or larger, at seaside resorts and other places, has raised a point which seems to be worth consideration. He suggests that promoters of these railways might give a little more thought to the possibility of "marrying" their locomotives to the locomotive history of their respective localities. For example, it is somewhat disconcerting to discover miniature L.N.E.R. locomotives operating in the south-eastern part of Kent, an area which has no association of any kind with L.N.E.R. engines. Surely, suitable types could be found among the Southern Railway's many powerful engines more appropriate to the district. But the idea is capable of being developed much further; for Mr. Maskelyne visualises a number of miniature railways on which the locomotives should be replicas of famous flyers of the past, built to scale but modernised as regards cylinders, valves and valve-gears, in order to ensure that such engines would be able to give the passengers some thrilling speed runs, in addition to the interest of being hauled by types of locomotives that won fame many years ago. A railway like the 15-in. gauge Romney, Hythe and Dymchurch line, intended primarily to serve a really useful service, but powered by locomotives based on prototypes which are not later than, say, 1914, would appeal to locomotive enthusiasts far and wide. Such a railway could scarcely fail to attract crowds of passengers, and, at the same time, it would have some value from the historical aspect. Among locomotive enthusiasts, the attraction of old-time types is enormous; any of the established societies and clubs devoted to the subject can endorse that statement. Therefore, who is to say that a railway planned on these lines would not prove to be a highly remunerative proposition?

Percival Marshall

A MINIATURE
MOTOR COASTER

by R. L. BUTLER

TO so many of us there is no finer sight than that of a passing ship, whether it be a large four-masted barque running under full canvas or a dirty little tramp, due for refit, entering the fairway. Why should these things remain only as memories? Why not try and bring them into one's home, an everlasting pleasure.



Mr. R. L. Butler's miniature motor coaster, reproduced about 50 per cent. larger than full size

With this object in view, a few years ago I started making model ships. Miniatures which take up so little room and allow one to keep quite a nice collection in a small space.

Many young modellers talk of snags, but what sort of a hobby would it be without them? Are they not the very pleasure of it all. As each fitting has to be made, think of the fun it is looking around for something that could be utilised. One can spend so many happy hours and make so many new friends in a hobby that can be made so inexpensive as regards both tools and materials. The only other things required are a little patience and time, and these cost nothing.

Let me put talk into practice by giving a description of my 1946 "M.E." exhibit.

An Original Model

In order to make an original model, I looked for a ship off the beaten track and chose the Anglo-American Oil Company's coastal tanker, the M.V. *Stourgate*, which I had many times seen off Ramsgate on her course between Purfleet and Sandwich. Through the courtesy of her master, Captain A. V. West, I was able to obtain her lines etc. from the builders' blue print and he gave me every opportunity of studying her fittings whilst in port. From these I carefully drew my chart to scale and proceeded to make the model. Now I have always made my little ships from metal because I find you can obtain such a fine finish, especially when it comes to painting. If you should have a slip with the paint, after all your trouble, it can be washed off. Not so easy with wood. I must have painted the *Stourgate* a couple of dozen times, but it was still the same old hull.

Taking a piece of $\frac{1}{4}$ in brass for the hull, I traced the deck plan from my chart and stuck it on the brass, first hack-sawing off the large pieces and then filing to shape, finishing off with a finer file. I then took a tracing of the profile of the ship and stuck this on the side of the brass and proceeded in the same way until I had the correct levels of the decks. Next I filed the bows and stern to shape. The hull was then sufficiently finished to proceed with the deck fittings.

The fore and aft bulwarks were filed from solid pieces of brass, the insides just inside the edge of the ship, the outsides a little larger than necessary. I will explain why, later.

Deck Fittings

Then the hatch, pump house, wheel house and engine room casing were filed to scale; also the base to fit the curve of the deck to which they were to be fitted. The wheel house was first filed to shape from the deck to the top of the windows. Then I drilled, with an ordinary hand drill, as large a hole as possible through the centre, from top to bottom, and from this the inside was filed with a small square file. The windows were then filed out. Now to fix all these fittings to the hull. You may or may not know that in order to

solder one must have all the parts equally hot. The thick piece of metal used for the hull is a little too much to solder with a mouth blowpipe and you may not have a blow lamp, so I will tell you what I did. After first laying a thin face of solder on the base of all the fittings, over a low gas ring, and smearing flux over the positions where the parts were to be soldered on to the deck, I bound these on to the hull by means of thin iron wire, making sure that every one was in correct position. The whole was then held over a gas ring until the solder flowed and next left to cool off thoroughly.

Any solder that had run off the mark was scraped off. The bulwarks which I told you to leave a little over the mark were then filed flat to the ship. The whole was then finished off with fine emery cloth and metal polish. The rest was simple. Paint lockers, companion ways, filed and stuck on. The wheel, made from an old watch wheel, fitted in wheel house, roof of wheel house fitted. The funnel was made from the tube out of a petrol lighter and pressed in a vice until oval in shape. The ship's boat from a piece of solid brass curtain rod, filed to sheer, flat at stern, bows shaped, inside cut out with firstly a graver and then a small file and emery cloth. Thwarts stuck in. Oars from thin brass wire flattened at ends to shape the blades. The hawse reel from brass wire for centre and small brass plates to form the rims at ends (no lathe required). Rigging of fine machine cotton. Mast and spars of brass wire.

The Only Snag

And then came my only real snag and it nearly finished my career as a model maker. I could not find anything suitable for the staunchion wires. One evening sitting by the firelight, one of my wife's silvery-grey hairs caught my eye, and I had it—in more ways than one. Anyway, like the good sport she is, the rest were forthcoming. Eight lengths only were required, but have you ever tried half-hitching human hair, it is a wonder she was not bald by the time the job was completed.

So you see, no costly tools are required, except for a micrometer, which is necessary if you intend to make an absolutely true-to-scale model. In conclusion let me give you four golden rules that I have learnt through experience and trust it will save you the mistakes that I made in the early days.

1. When you set out to make a model, take a named ship and either obtain a blue print from the model publishers or go to the master of a local ship, tell him your ambition and see if he can help you. I have found these men only too keen, in fact, in my every instance, as keen as myself. Follow the blueprint chart from stem to stern, everything to scale and you cannot possibly go wrong.

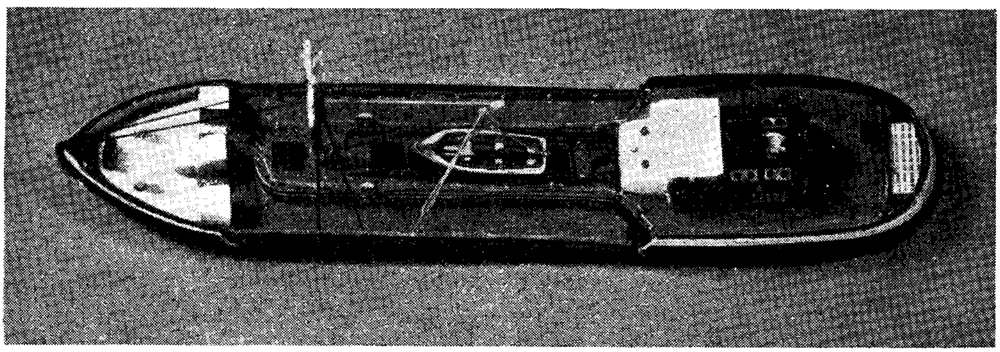
2. Take your time. What I have told you may seem so easy—it is, but not if you hurry. File and file, polish and polish. When you paint still take your time. Place it under cover to dry, to avoid dust spoiling your effort, and let it dry thoroughly even if it takes weeks, If you intend to exhibit your model do not start to make it about a week before the exhibition.

3. Put in all the details you possibly can, but, if any are too small for you to make to scale, then leave them out. Nothing spoils a model more than having the fittings out of proportion.

4. When your model is completed, enter it in the "M.E." Exhibition. The small entrance fee gives you free admittance as many times as you wish and enables you to see all kinds of models. those made by beginners like yourself and those by older and more experienced modellers. *And*, this means so much to you, your model will be examined by some of the finest experts in the land. Men who have been chosen as judges because they themselves have produced models of the finest class. Their criticism is good, and it is free.

If you do not obtain an award, do not be disappointed. Just look at the winning models, see what is wrong with your own and go home and make a better one. If you do win an award then perhaps you will feel as excited as I did, and start on still a better and then an even better model.

It has been written that the pen is mightier than the sword, maybe, but to me the file is mightier even than the pen.



An "aerial" view of the miniature motor coaster. The length of the model is as long—or short—as a cigarette

PETROL ENGINE TOPICS

* A 15-c.c. FOUR-CYLINDER ENGINE

By Edgar T. Westbury

AS in the case of the carburettor and manifold system, the design of a suitable ignition system for this engine has presented quite a number of practical problems, due to the desirability of keeping the size of the components down to something like scale proportions, and at the same time fairly straightforward in construction and accessible for adjustment. The arrangement which is almost universally adopted on full-sized engines—namely, a unit comprising the low-tension contact-breaker and high-tension distributor, for operation with a single ignition coil—was decided upon as equally suitable for this small engine, and in a general way, the design presents no difficulties except those imposed by its diminutive size ; but these are by no means insignificant from the practical point of view.

It has been necessary to make some readjustment of the details of these components since the engine was first designed, mainly to meet increasing difficulties and restrictions in the availability of supplies. Plans were made for obtaining a pressure moulding of the distributor casing and rotor, with metal conducting inserts, to make these practically a true scale replica of the components used in full-size practice, but in view of the many delays and set-backs which have occurred with other details, it has been considered better, or at least more judicious, to design these parts, so that they can be machined or fabricated from stock material. This may detract from the neatness and attractive appearance of the ignition fittings, but in no respect does it make them any less efficient or reliable.

The distributor and contact-breaker is shown in Fig. 39, which represents a section on the axial centre line, showing the way the unit is fitted to the timing case of the engine and driven from the end of the camshaft, and a face view of the contact-breaker only. It will be seen that both the contact-breaker cam and the distributor rotor are mounted on the extended end of the camshaft, outside the nut which secures the timing gear ; the cam being pinned to the shaft, and the rotor located and driven by a peg fitted to the face of the cam.

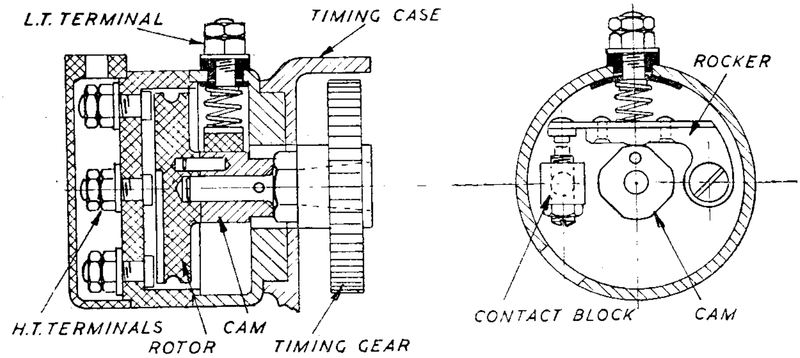


Fig. 39. Section of distributor assembly, showing arrangement of unit on timing case, and face view of contact-breaker

The contact-breaker housing is of metal, preferably of light alloy, and can be machined from the solid ; plastic material of known insulation efficiency and good machining quality, such as ebonite, vulcanite, or phenol resin (bakelite) having fine-texture fabric or paper pulp base, is used for the distributor block and terminal cover, and these parts also can be machined from the solid. They are registered in alignment by spigot joints, and it is intended that the entire unit assembly should be held in place by a spring clip and stud in the timing case, similar to that used for holding a magneto contact-breaker. Alternative methods may suggest themselves, and may be used at the option of the constructor, but this will be quite satisfactory for most practical purposes, and it is perhaps the simplest, not only in construction, but also for accessibility.

Contact Breaker Casing

A piece of aluminium alloy rod large enough to clean up to $1\frac{1}{4}$ in. diameter is used for this, and may be machined on the outside, end face and spigot, then reversed and bored out from the other side. The spigot should be a close fit in the recess of the timing case, and very slightly shallower in depth, so that it bears on the outer rim when pressed home. It will be seen from the sectional view of the unit that a slight modification has been made to the timing case by boring out the centre of the recess to the same size as the hole through the casing—namely, $\frac{7}{16}$-in. diameter. This hole does not form a bearing or register but is simply a clearance for the cam and the timing gear nut, so that

**Continued from page 768, Vol. 96, " M.E.," June 26, 1947.*

neither its diameter nor its concentricity with the recess are of vital importance. It is, however, essential that the recess in the contact-breaker casing should be concentric with the spigot, and that the outer face should be parallel with the back flange, so it is advisable to turn up a simple chucking ring into which the component can be pressed for the second operation.

Two holes are drilled axially through the back face of the casing, diametrically opposed at a radius of $\frac{3}{8}$ in. from the centre. One of these is tapped 4-B.A. and the other drilled 9/64 in., to take the shank of the contact block a close fit. This hole is counterbored with a pin drill or similar cutter to a depth of 3/32 in. from the spigot face so that the nut securing the contact block will sink flush with, or below the surface of, the spigot. Two more holes are drilled in the outer rim of the casing, one being at 90 deg. to the centre line of the axial holes, 5/32 in. diameter to take the bush of the L.T. terminal, while the other is simply an access hole for the contact-breaker screw, drilled $\frac{3}{16}$ in. diameter at an angle of about 45 deg. to the vertical centre-line, so as to come immediately below the contact block.

Distributor Block

This is turned from insulating material, and the most important essential is the fit and concentric alignment of the registering surfaces; a good method of procedure is to turn the inner face, with its rim, spigot and recess, first, and then turn a metal spigot on which to mount the block for facing and spigoting the outer side.

The five axial holes for the conductor studs should be drilled to a close fit for the shank of a 6-B.A. screw; if suitable material is available it will be better still to tap these holes, but it will be necessary to counterbore to clearance size from the inside to allow the studs to bed down to the heads if this is done. Ordinary brass 6-B.A. screws, $\frac{5}{16}$ in. long, may be used for the conductor studs, and after being secured in place, the heads may be machined off from the inside to about 1/32 in. thick, that is, 7/32 in. from the front face of the spigot. The two tapped holes in the block are for the purpose of fitting screws to hold the terminal casing in position, but may be dispensed with if the parts are made a good fit, as the spring clip will normally keep the cover in place, and the use of screws is open to certain objections, as there is a slight risk of their picking up H.T. current from the rotor segment and causing leakage or shocks.

Terminal Cover

The fitting of a cover over the H.T. terminals is at least a highly desirable, if not essential precaution, not only for the sake of neatness but also to avoid leakage of current. Most distributors used in full-size practice employ terminal sockets or insulated terminal nuts, but while these are equally practicable in a small size, they are somewhat difficult to produce unless moulding facilities are available. Taking things by and large, there is nothing to beat an ordinary terminal nut for security and accessibility, and by covering the whole set of terminals, the connections of the leads are projected in the simplest possible way. The cover is made of the same material as the distributor block, and its machining calls for no special comment. If desired, it may be made a plain circular shape and the leads brought out radially at any desired point; but bringing them out all in a row, through a section of material thick enough to guide and prevent kinking of the leads, has obvious advantages, and enables the leads to be taken neatly and directly to the plugs. It will be seen from Fig. 41 that by inclining the cover at an angle of $22\frac{1}{2}$ deg., the shortest and most direct path is obtained for the leads, and if screws are used to secure the cover, they should be located as shown to ensure this. The use of P.V.C. insulated leads is recommended, and a suitable size of lead which is a fairly neat fit in the $\frac{1}{8}$-in. holes in the cover is, I believe, generally available.

Internal Components

Details of these parts are given in Fig. 40, the first being the contact block, which is made from brass or light alloy, either of square section or flattened on the sides, and turned down and screwed 4-B.A. at one end. The cross hole for the contact screw should be square with the centre line and across the diameter. Small headless 6-B.A. tungsten tipped screws are available, but other sizes of screws, up to a maximum of about 4-B.A. or the Bosch standard of 3.5 m.m. may be used. The block is firmly secured in the casing by the flush-fitting nut in the counterbore at the back, which can be tightened with a tubular box spanner; or a slotted nut, for manipulation with a forked screwdriver, may be used.

In machining the cam, which is made of mild-steel, it is most essential that the four flats should be equally spaced and concentric with the axis. The use of an indexing device on the lathe mandrel, in conjunction with a milling attachment or roller filing rest, will be found very helpful in ensuring this. Another method which might be employed is to make the cam from square section steel bar, setting it up in the four-jaw chuck with the aid of a test indicator, to ensure that the four sides are exactly the same distance from the centre. $\frac{5}{16}$ in. diameter square bar could be used, providing that a corresponding modification is made in the rocker dimensions to suit.

The flats should each be about 45 deg., in width, or in other words, the rounded and flat portions of the cam surface should be about the same width. Too wide a flat will waste battery current, while if it is too narrow, the coil will not become properly saturated at high speed, and ignition efficiency will thereby fall off. But the really important thing is that the cam breaks should occur at exactly 90 deg. to each other.

The centre hole of the cam should be chamfered or counterbored at the back so that it can be pressed on to the shaft to seat against the face of the timing gear nut. It is best secured on the shaft by means of a small cross pin, but this should not be fitted until the ignition is timed up, and the same applies to the driving peg or dowel for the distributor rotor. Final case-hardening of the cam is recommended.

For making the contact-breaker rocker a really

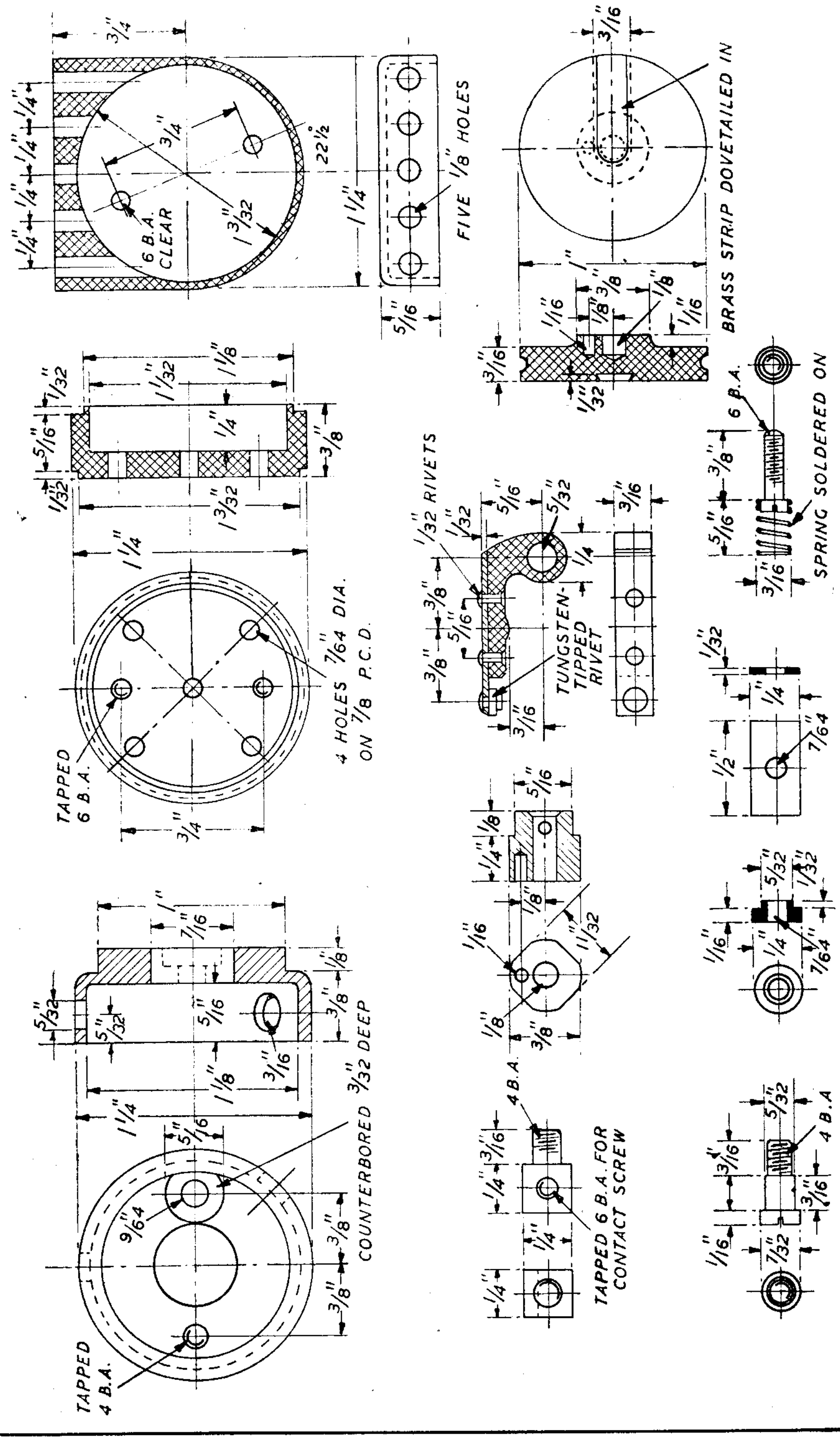


Fig. 40. Details of components for distributor unit

tough plastic material, such as laminated fabric bakelite, is best. Alternatively, the rocker could be made of metal (preferably steel), with fibre pivot bush and rubbing pad inserted. It will be clear that this part must be insulated from contact with both the pivot screw and the cam. A strip of 1/32-in. or 20-gauge spring steel plate is used to carry the contact rivet, assuming that the form of construction is as drawn, and this in turn is riveted to the body of the rocker; two brass pins may be used for rivets, and should have the heads slightly countersunk into the plastic material, and afterwards filed flush so that there is no risk of them touching other metal parts. A slight hump is left between the rivet heads to act as the rubbing pad to rest on the cam surface.

The pivot screw is of mild-steel, and the plain part should be just long enough to allow the rocker to work without end play when it is screwed tightly home in the casing. A washer 1/32 in. thick is placed behind the rocker to raise it clear of the inner face of the casing, and care should be taken to see that when the working parts are assembled, the rocker blade cannot touch any metal, other than the top of the contact screw, under working conditions.

A fibre or ebonite insulating washer is made to fit the hole in the casing, over the rocker, and a slip of fibre or leatheroid, of the dimensions shown, is fitted inside the hole. The screw which forms the L.T. terminal is an ordinary 6-B.A. brass screw, $\frac{3}{8}$ in. long, the head of which is turned down to fit inside a compression spring of about $\frac{3}{16}$ in. external diameter, and preferably soldered thereto. This spring forms the electrical connection to the rocker, and should bear firmly on the centre of the blade, between the rivets, also it should be kept clear of contact with the casing.

The distributor rotor is turned from the same material as that used for the casing and terminal cover, and should have sufficient clearance in the casing to avoid risk of rubbing contact. Its edge is grooved or serrated to provide the maximum length of leakage path around the rotor, and thereby minimise risk of tracking or flashover of the H.T. current. The centre hole at the back of the rotor should not go in deeper than is necessary to locate it properly on the shaft, against the face of the cam.

A brass strip is attached to the front face of the rotor, flush with the surface of the disc, the method recommended being to mill out a radial groove with a $\frac{3}{16}$-in. undercut or "dovetail" cutter, and shape the strip to press in fairly tightly, but not so as to strain or split the disc. No other securing should be necessary if the fitting is good, but if desired, a small hole may be drilled through strip and rotor at about half the radius and an ivory peg driven through, to prevent shifting of the strip under centrifugal force. The face of the rotor and the strip should be machined or lapped down flush, and when the parts are assembled, this face should run within about 0.005 in. of the faces of the conductor studs in the distributor block.

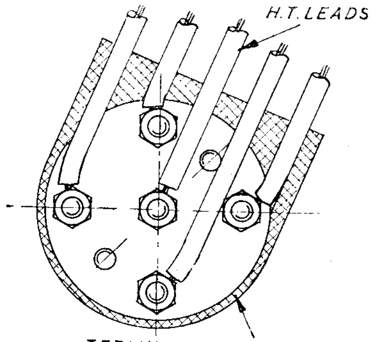


Fig. 41. Section of distributor terminal cover

Assembly

The most important point in assembly is to time both the contact breaker and distributor rotor. It will be noted that the unit is capable of being turned to any position and that no operating lever is shown for the advance or retard control. It will, of course, be necessary to arrange for such control in most cases, and a suitable lever can be attached at any convenient point on the casing, either by providing it with a concave foot which may be attached with a couple of screws, or making it in the form of a stud which is screwed into the casing radially or nutted on the inside. Alternatively, the L.T. terminal shank could be extended to form a control lever, so long as it is remembered that this terminal is "alive" at battery voltage, and therefore must not be connected in metallic contact with anything on the engine structure.

In timing up the ignition system, it will first of all be necessary to determine the angular position of the breaker casing, and settings are best made from the retarded position, which is approximately top dead centre. The fitting of stops to limit the extent of advance and retard is a sound policy, as it avoids the need for "searching" when starting or adjusting the engine; but they have not been specified on the drawings, owing to the variations of arrangement which are possible.

The cam should be adjusted so that the points just break as the engine comes up at top dead centre, and pinned in position on the shaft; either break may be timed for any cylinder, as they should all be alike and equally spaced. The distributor rotor is then located by the driving peg, so that the conducting strip comes opposite one of the stud faces. Here again, either of the four studs will serve, so long as, when the leads are connected, the sequence is arranged so that each plug gets its current as the respective piston comes up on its firing stroke. Timing up an engine is really a very simple business, which only requires a little careful thought, though it is often regarded as a major mystery.

It is advisable either to mark the relative positions of the contact breaker casing and distributor block, or to locate them positively with a small peg in the register spigot, as it is otherwise possible to get the rotor conductor out of line with the studs. The fit of the parts, and the spring of the retaining clip, should be sufficiently tight to ensure that there is no risk of the assembly shifting under working conditions.

It is not anticipated that any trouble will arise through oil leaking from the timing case into the distributor, as centrifugal force will tend to throw it away from the aperture between them;

but it is quite an easy matter to fit a felt washer or other sealing device behind the cam if it should be found desirable to do so.

An alternative arrangement for the contact-breaker and distributor, for use in cases where it is desired to fit an oil or water circulating pump will be described later.

Another Correction

Despite the utmost care in the setting-out of the camshaft, I have discovered, thanks to the co-operation of a constructor, that I made a slip-up in the sequence of the valve events. But keep your seats and don't panic—it will not make an atom of difference to results! It is just another case of "minding my 3's and 2's," as I said the other day. The firing order, which was described as 1-2-4-3, in the issue of May 1st, actually comes out 1-3-4-2 when working to the instructions given. So long as the ignition is timed accordingly, by taking the leads to the plugs in the same order, the working of the engine is unaffected. The error arose due to the apparent paradox (there are quite a few of them in working out these little problems) that shifting the pointer anti-clockwise relative to the camshaft is equivalent to shifting the camshaft clockwise relative to the division plate; the sequence is thus reversed, though the relation of exhaust to inlet on any one cylinder is the same.

I have also to congratulate the above constructor for making an excellent job of the camshaft which he has submitted for my inspection.

(To be continued)

For the Bookshelf

Model Petrol Engines. By Edgar T. Westbury. (London: Percival Marshall & Co. Ltd. price 7s. 6d., postage 6d.)

In view of the widespread popularity of model petrol engines, second only perhaps to that of model steam locomotives, it is surprising that so few handbooks have been written upon the subject. In fact, beyond a pioneer and praiseworthy effort by the same publishers many years ago and a notable contribution by a well-known French author, which has unfortunately never been translated, there is little in book form for the designer and constructor, as distinct from the user, of these small engines.

It is therefore most satisfactory that no less an authority than Mr. E. T. Westbury should fill the gap with an entirely new book

Divided into ten chapters, in addition to the usual preface and a useful appendix, all aspects of model petrol engine design and construction are covered in a manner which, while not being beyond the grasp of a newcomer to the subject, are nevertheless worthy of close consideration by the more expert.

In the early chapters, principles of operation and some definitions of various forms of efficiency are given. Here perhaps over-simplification leads to some statements which are not academically correct, as, for example, the assertion that the Carnot Cycle must work between infinite temperature limits. However, the information will be more than sufficient in its scope for the general reader, and forms a fitting introduction to the latter chapters.

Here a wide range of practical examples of design and construction emphasise the full extent of model petrol engineering. that is apart from the now conventional application of single-cylinder engines to speedboats, aeroplanes and race cars. The book is illustrated with numerous drawings from the author's own drawing board, and the addition of many photographs of other noteworthy and interesting models prevents it from being in any way a "one-man show."

Separate chapters are devoted to the all-important ancillaries of any petrol engine, the carburettor, the ignition, lubrication and cooling systems and to the very practical matter of tuning and testing model engines for all purposes.

Since technical reviews are not supposed to be complete without a catalogue of misprints, it is fair to say that the only obvious one is on page 217, where all but devotees of the ultra miniature will need to read cubic centimetres for cubic millimetres in computing the capacity of their engines!

In conclusion, it may be said that this is a book that will be welcomed by all who design and construct model petrol engines as well as by those who from choice or necessity use the ready-made article. It can be recommended too to the model engineer who has not yet entered this sphere and is looking for new worlds to conquer.—D.H.C.

Examples of Engineering Drawing and Design (Volume Three). By H. Binns. (London: Hodder & Stoughton Ltd., Warwick Square, London, E.C.4.) Price 6s., postage 9d.

This is the third of a series of handbooks, which, together, comprise a complete three years' course in engineering drawing for students. The present volume introduces elements of machine design, and contains information on the application of principles such as factors of safety, stresses of various kinds, fatigue, friction, etc., to the design of machines or components of established types. Examples embodying these principles are illustrated both in orthographic and isometric projection, and the calculations involved in designing them are shown.

The book is intended particularly for the use of students who are studying for the National Certificate or B.Sc. in engineering, but is of practical value to all engineering draughtsmen and designers.

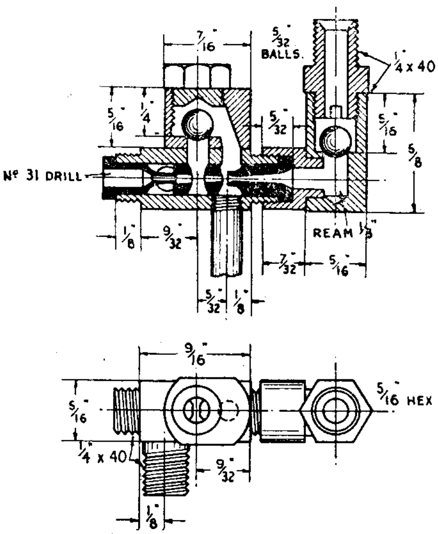
"L.B.S.C."

Injector for "Hielan' Lassie"

ALTHOUGH the injector described below is primarily intended for the "Lassie," it is quite suitable for any $3\frac{1}{2}$-in. gauge locomotive, and can be also used for $2\frac{1}{2}$-in. gauge boilers if they are not particularly small. If any beginner building "Juliet" wishes to fit injector-feed, this one will fill the bill, and no beginner need be afraid of tackling it. It isn't such a long time ago that injectors, like mechanical lubricators and other fitments of like nature, were regarded as kind of "proprietary articles," only to be purchased, or made by the exclusive few who had an elaborate outfit of precision tools and a drawerful of micrometers, slide gauges, and goodness-only knows what else, plus years and years of experience. Not for the "common herd"—bless your hearts and souls, oh dear no! But it came to pass that a certain irresponsible person who rejoices in the name of Curly, started in to tell all and sundry how to do the job, in these columns; and that promptly knocked the bottom out of all the "hidden mysteries" so that all the Toms, Dicks, and Harrys started making jiggers, and wondered why they believed all the "difficult" yarns and never had a shot before.

Injector Body

No castings are required; the whole doings can be made from a few scraps of brass rod, any quality being suitable, even commercial "screw-rod." Saw or part off a bit of $\frac{5}{16}$-in. square rod, to a length of $\frac{13}{16}$ in. full, and chuck truly in the four-jaw; if sawn, allow sufficient for facing the ends truly. Face, centre, drill right through with No. 24 drill, and poke a 5/32-in. parallel reamer through. Turn down $\frac{1}{8}$ in. of the outside to $\frac{1}{4}$ in. diameter, and screw $\frac{1}{4}$ in. by 40. If you slack Nos. 1 and 2 jaws, reverse the piece of metal, and tighten the same two again, the work should still run truly, and the other end can then be turned and screwed in like manner; or if you like, you can chuck the piece by the screwed end in a tapped bush held in the three-jaw. You can go from London Bridge to Charing Cross *via* Waterloo Junction, or *via* Timbuctoo and Chicago, but it doesn't matter as long as you arrive safely! Now follow carefully: drill a $\frac{1}{8}$-in. hole in the middle of one side, and call that the top. At $\frac{3}{16}$ in. farther along, drill another one, which will leave $\frac{1}{16}$ in. of metal between the two, they must not approach any closer. Turn the piece over on its side, and drill a 5/32-in. hole, on the centre-line, $\frac{1}{8}$ in. from the shoulder, and at the opposite end to the one last drilled. Now turn the piece over again, and on the opposite side to the two holes first drilled, drill another using No. 30 drill, $\frac{1}{8}$-in. from the shoulder, tap this 5/32 in. by 40. All the holes should break into the passage through the middle, but don't let the drill touch the opposite side of the bore; then run the 5/32 in. reamer through again to clean out any burrs.



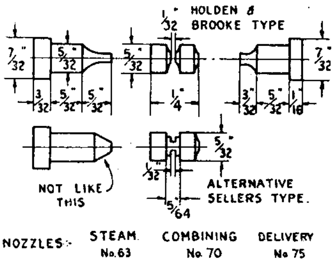
Section and plan of injector

Valve-Box

Chuck a piece of $\frac{7}{16}$-in. round brass rod in three-jaw; face the end, and part off a $\frac{5}{16}$ in. length. The tool marks will indicate the true centre; at $\frac{1}{16}$ in. away from this, make a centre-pop, and chuck the piece in the four-jaw with this running truly. Run a centre-drill into it, follow up with a No. 33, going right through the piece, open out to $\frac{3}{16}$ in. depth with 7/32-in. drill, bottom to $\frac{1}{4}$ in. depth with 7/32-in. D-bit, tap the hole $\frac{1}{4}$ in. by 40, taking care not to let the tap spoil the ball-seat, slightly countersink the end, and run a $\frac{1}{8}$-in. parallel reamer through the remaining bit of hole left by the No. 33 drill. Next, on the underside, make a centre-pop a full $\frac{3}{16}$ in. from the centre of the reamed hole; and from this, drill a $\frac{1}{8}$-in. hole on the slant, into the ball-chamber, as shown in the section of the complete injector.

Fit a $\frac{1}{4}$-in. by 40 union nipple in the side hole; you should know how to make these upside down and backwards by now, after making them for the boiler fittings, lubricator clacks and what-have-you. Set the valve-box on top of the body, so that the reamed hole lines up with centre hole in same, and the inclined hole registers with the end one in the body. Tie in place with a bit of iron binding-wire, or hold the bits together with a home-made brazing clamp (like a toolmakers' cramp, knocked up roughly with a couple of bits of $\frac{5}{16}$ in. square steel, with ordinary $\frac{3}{16}$-in. stove screws; anything does for a job like that) and silver-solder the valve-box to the body, and the nipple into its hole, at the one heat. Pickle,

wash off, and clean up. If any of the silver-solder has run into the threads, go over them with a die again. Seat a 5/32-in. rustless steel ball in the valve-box, and make a little cap from $\frac{5}{16}$-in. hexagon brass rod, as described for clacks; but make a countersink in the middle, as shown in the section, allowing the ball a full 1/32 in. lift. The projecting sides of the valve-box can then



Cones

be filed flat, or milled off, for the sake of appearance, as shown in the plan view.

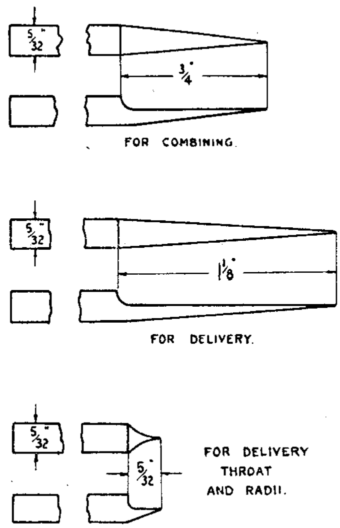
Cone Reamers

Drilling and reaming cones to the right diameter and taper, is usually considered the "pons asinorum" of amateur injector makers; and mention of the said "p.-a" reminds me that once, in the far-off days of childhood, my mind was so far away on my beloved railway during the geometry lesson, that when the teacher asked me what were the extremities of a line, I replied artlessly and absent-mindedly, "Please sir, buffer stops." Teacher and class went into convulsions; when the former recovered his composure, he promptly set all the class off again by remarking "And I suppose Dolly's idea of a straight line is the bit that goes from London Bridge to Brighton!" Incidentally, it was that teacher's method of imparting information *by making it interesting*, that I do my best to follow in writing these notes.

However, the first step towards getting the cones correct is to make the necessary reamers for forming the tapers. Three bits of of 5/32-in. round silver-steel bout $2\frac{1}{2}$ in. long are needed. Chuck one in three-jaw, and turn a taper on it $\frac{3}{4}$ in. long from base to point; the slide-rest should be set over about $4\frac{1}{2}$ deg. for this. The second has the taper $1\frac{1}{8}$ in. long, the slide at about 3 deg.; the third has a curved point 5/32 in. long, formed with a round-nose tool. The exact radius doesn't matter, as long as the end is acute, as shown, and not blunt. File away half the diameter of each taper; heat to cherry-red and plunge into cold water, point first. Rub the flats on a piece of fine emery-cloth, or for preference, carborundum or aloxite, which cuts quicker, and take care not to destroy the sharp edges; but have the flats quite bright. Then place them on a piece of sheet-iron, and hold over a gas, spirit, or blow-lamp flame. When the bright part turns to medium yellow, tip the reamer into cold water quickly. Finally rub the flats on a smooth-grained oil-stone, and the reamers are ready for use.

Combining or Mixing Cone

Make the combining-cone first. This has to be a tight fit in the injector body; and to ensure this, here is a t p for beginners. Broach the "entry" end of the body (that is, the end which carries the union-nipple at the side) with an ordinary taper-pin broach; not much, just about $\frac{1}{8}$ in. or so into the bore. Chuck a piece of $\frac{3}{16}$-in. round brass rod in three-jaw, and turn down about $\frac{1}{2}$ in. of it to a full 5/32 in. diameter, using a round-nose tool. Now very carefully reduce the end for about $\frac{5}{16}$ in. length, to a diameter that will just (and only just) enter the broached end of the injector body. Face the end, centre, and drill down to $\frac{5}{16}$ in. depth with a No. 72 drill. That sounds fine, says you; but how do we do it without breaking the drill, and anyway, the centre-drill will make a far bigger hole than No. 72, so what? Well, everything is easy *when you know how*; and here is the "how." Don't use an ordinary centre-drill, for the start; make a special one. Turn a fine cone point about $\frac{1}{4}$ in. long, on a couple of inches of $\frac{1}{8}$-in. silver-steel; then, with a fine file, form the extreme tip into a weeny-weeny arrow point. Harden and temper this, same as the cone reamers; and if applied to the work in the same way as a centre-drill, it will make a tiny depression that will be just right for starting any very small drill in the "straight and narrow path." I use broken-off dental burrs for making "centre-drillettes."



Cone reamers

Don't forget that you only want to touch the work lightly with it; it must not be forced to cut a deep depression like that made by centre-drills of the Slocomb type.

To drill the hole full depth without making your own pocket lighter—don't confuse that with the one that is used for lighting cigarettes!—and the drill manufacturer's pocket heavier, keep working the drill in and out of the hole, like a piston-rod in and out of a cylinder. I use a lever tailstock, but it can be done with the ordinary screw tailstock, though you should be

careful not to put too much pressure on the drill when feeding in. In 90 per cent. of the cases of broken drills, the casualty is caused by chippings choking the tiny flutes and causing seizure ; so don't let the drill penetrate more than $\frac{1}{16}$ in. at each " bite," and flick the chips off with your finger, when withdrawing, if they don't fall off of their own free will and accord.

Cut back the end of the rod just a little, to form a very blunt nose, as shown in the illustration, and part off $\frac{1}{4}$ in. from the extreme end. Now comes the ticklish part, but there is nothing alarming about it. Put the end of the $\frac{3}{4}$-in. taper reamer into the 72 hole, and note exactly how far it goes in. Then chuck the embryo cone in the three-jaw, the other way around, nozzle end inwards, and put the reamer in the tailstock chuck. Carefully enter the reamer into the cone $\frac{1}{4}$ in., plus the amount the point entered when you tried it in the hole. This amount should, of course, project beyond the nozzle end, when the taper reamer is entered to the correct distance. I use a stop on my reamers, made from a bit of $\frac{5}{16}$-in. brass rod about 1 in. long, drilled No. 20 and furnished with a 3/32-in. set-screw at one end. This is set to the correct distance from the point of the reamer, and the set-screw tightened ; and it is then impossible to " overshoot the platform " in a manner of speaking. Finally, put a No. 70 drill through the end of the taper hole, which will bring the orifice exactly to required size ; and also take the sharp edge off the end of the hole with the short reamer.

The cone can be finished either to the completely divided Holden and Brooke pattern, or the Sellers slotted type. In the former case, chuck the cone in three-jaw, with a shade over half projecting, and saw across with a very fine hacksaw ; I use the kind sold for jeweller's work. Skim up the sawn faces, and cut them back slightly, as shown in the detail drawing, taking the sharp edge off the entry side of the taper hole in the smaller-bored half. Put them on the cone reamer, to test if the gap between the two halves is correct ; it should be approximately 1/32 in. Press home in the injector body, using the bench vice as a squeezing medium, and a piece of $\frac{1}{8}$ in. brass rod with a slightly countersunk end, as a " ram-rod." Put the nozzle end in first, and press until the trailing end of it is just past the bottom of the hole at the bottom of valve box—see plan view ; then press in the other to within 1/32 in. of it. Test with the cone reamer ; if there is no shake, the cone is O.K. To finish to Sellers type, chuck the cone with 5/32 in. projecting from jaws, and carefully form a shallow groove with a $\frac{1}{16}$-in. parting-tool, worked as close to chuck jaws as possible. With a fine file, or a saw, 1/32 in. thick, cut a couple of small slots, just breaking into the taper bore. Run the reamer in, to remove any burr, and then press the cone into the injector body so that the groove is exactly under the hole at the bottom of the valve-box.

Delivery Cone

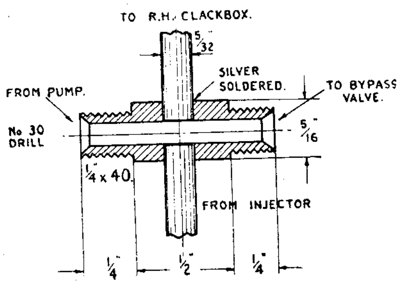
Chuck the $\frac{1}{4}$-in. rod again, turn down $\frac{3}{8}$ in. length to 7/32 in. diameter, and a further $\frac{1}{4}$ in. length to a push-fit in the injector body, using same as a gauge, and checking length by sighting through the overflow hole. When pushed in to the shoulder, the end of the rod should clear the end of the combining cone by a bare 1/32 in. Now centre and drill as above, using No. 76 drill, penetrating a full $\frac{5}{16}$ in. ; or if you like, you can drill half-way, and open out the other end with a little larger drill before reaming. Next, with the shortest reamer, bell-mouth the end of the hole to a diameter of $\frac{1}{16}$ in., and turn the end to the shape shown ; the diameter outside the bell-mouth should be approximately 3/32 in. Part-off at $\frac{5}{16}$ in. from the end. Reverse in chuck, and ream with the longer taper reamer until the point just shows at the bottom of the bell ; beginners had better do this bit by trial and error, reaming until they can just see the tip of a No. 75 drill showing in the hole, but c nnot push it through when stationary. Then re-chuck the cone, and put the 75 drill through whilst running. As the average tailstock chuck won't grip these small drills, hold them in a jeweller's pin-chuck, the shank of that (about $\frac{3}{16}$ in. diameter) being gripped in the jaws of the tailstock chuck. Only sufficient of the weeny drill should project from the pin chuck, for the depth of hole required. Finally, bell the trailing end of the hole to about 7/64 in. diameter with the stumpy reamer.

Steam-Cone

Chuck the $\frac{1}{4}$-in. rod once more, turn down about $\frac{1}{2}$ in. to 7/32 in. diameter, and a further $\frac{5}{16}$ in. to a push-fit in the nipple end of the injector body. When pushed in, the shoulder should be a full 1/32 in. clear of the end of the body, when the end of the turned part is touching the combining cone. Centre and drill as above, using No. 64 drill, and going about $\frac{7}{16}$ in. deep. Run the $\frac{3}{4}$-in. taper reamer into the end of the hole far enough to allow a No. 75 drill to enter $\frac{1}{8}$ in., then turn the outside for 5/32 in. length to a gradual taper as shown. From time to time, I have had complaints from correspondents that injectors would not work, assuring me that they had been made strictly to " words and music." In practically all the cases in which I have asked to see the delinquents, I have found the steam cone turned as shown in the illustration of how *not* to do it, included specially as a warning! The nozzle end should be almost parallel, and the orifice very nearly knife-edged ; if you have a " mike," the diameter on the outside should be between 0.055 in. and 0.060 in. Part-off to leave a flange about 3/32 in. in thickness ; reverse in chuck, and open out the hole to a depth of $\frac{1}{4}$ in. with a No. 31 or $\frac{1}{8}$ in. drill. Very slightly countersink the bottom of the hole with the $\frac{3}{4}$-in. taper reamer, so that if you put a 63 drill in, you can just see the tip down the other end, but can't push it through ; then chuck the cone again, and put it through with the lathe running. By that means you get the holes the exact size. When the cone is home, the nozzle should enter the combining-cone a full 1/32 in. That completes the vital components of the tiny scrap of squirting apparatus—and *can* it squirt ? Imagine the amount of " punch " needed in a jet of water the thickness of a doll's pin, to bump a clack valve with 80 lb. pressure on the ball ; yet it does that easily !

Delivery Check-Valve

The body of the check-valve is made from a piece of $\frac{5}{16}$-in. rod; gun-metal or bronze is better for this, as it makes a more lasting ball-seating. Chuck in three-jaw, face, centre, drill $\frac{9}{16}$ in. depth with No. 33 drill, open out and bottom with 7/32 in. drill and D-bit to $\frac{5}{16}$ in. depth, tap $\frac{1}{4}$ in. by 40, countersink slightly, and put a $\frac{1}{8}$-in. parallel reamer down the blind hole. Part-off at $\frac{5}{8}$ in. from the end. At 5/32 in. from the bottom, drill a 5/32-in. or No. 20 hole, breaking into the reamed one. Chuck the $\frac{5}{16}$ in. rod again, centre, drill $\frac{1}{8}$ in. or No. 30 for $\frac{3}{8}$ in. depth; open out and bottom with 7/32-in. drill and D-bit to a bare $\frac{3}{16}$ in. depth, and tap $\frac{1}{4}$ in. by 40. Part-off at $\frac{5}{16}$ in. from the end, reverse in chuck, and turn $\frac{1}{16}$ in. of the end to a tight squeeze fit in the hole in the clack body. Squeeze it in and silver-solder it. Seat a 5/32-in. rustless steel ball in the body, and fit a union cap made in the



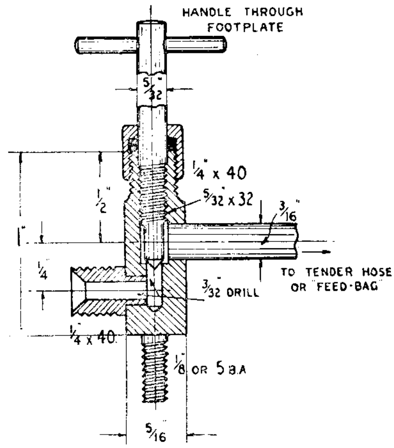
Connector for feed pipes

way described for the engine and tender pumps, to the sizes given on the drawing; the ball can be allowed a little more lift, as it stays up all the time the jigger is at work, instead of bobbing up and down like a pump-valve. An injector likes plenty of room for its feeding antics! Screw the completed gadget on to the delivery end of the injector, and if it doesn't come up straight when tight home, take a little skim off the flange of the delivery cone until it does.

How to Connect Up

On what our radio friends would call the schematic diagram of the pipework, I showed a double tee for connecting the injector and pump feeds to the same delivery clack, and this can easily be made by silver-soldering a couple of $\frac{1}{4}$-in. by 40 union-nipples into an inch of $\frac{5}{16}$-in. round rod, drilled 5/32 in. to take the pipe at each end; but I fancy it would be better in the present case, and easier at that, to give the injector feed a direct run, by aid of a simple cross fitting. The drawing shows the idea. The cross is made from an inch of $\frac{5}{16}$-in. round brass rod, countersunk, turned down and screwed both ends $\frac{1}{4}$ in. by 40, and drilled through with No. 30 drill. A 5/32-in. hole is drilled right across the centre, and two lengths of 5/32-in. copper tube silver-soldered into the hole as shown. These are furnished at their outer ends with union-nuts and cones, one being attached to the injector check-valve, and the other to the right-hand clack-box, the cross being located just below the footplate, with the screws pointing fore and aft. The delivery-pipe from the engine pump is connected to the forward union, and a short pipe goes from the back union to the by-pass valve. The exact lengths of pipe are measured from the actual job, as mentioned in a previous note, by using a bit of wire as template.

The injector itself can be located just ahead of the drag-beam, placed crosswise, and low enough to be accessible; its exact position doesn't matter. A short bit of 5/32-in. pipe, with union-nut and cone, is attached to the side nipple, and goes through the other hole in the



By-pass valve

bracket carrying the hand-pump connection, a piece of $\frac{3}{16}$-in. pipe being attached between the jigger and the bracket (what the permanent-way gang would call an "end-on junction") so that a $\frac{3}{16}$-in. rubber hose or "feedbag" can be used. The steam end of the injector is connected to the valve on the back-head by a piece of 5/32-in. pipe with a union-nut and cone at the upper end, and a 7/32-in. flat flange at the injector end, which butts up against the end of the steam-cone and makes a steamtight joint. The three pipes—steam, water, and delivery—provide all the support the injector needs, and no further fixing is necessary. To dismantle it for cleaning, merely unscrew the three union-nuts, a few seconds' work, and it falls out. A piece of 5/32-in. copper tube, bent as shown on the pipe diagram, can be screwed into the overflow hole, the outer end being attached to the underside of the step, when that is fitted, by a small clip. The enginemen can then see at a glance if any dribble is taking place; otherwise, simply screw an inch of tube into the hole, and let it discharge any surplus water, when starting up, between the rails.

By-pass Valve

As this is made by the same process as described for injector steam-valve, blower-valve and so on, detailed instructions would be superfluous; use the methods described, working to the dimensions given on the illustration,

(*Continued on page* 41)

*WATCHING THE WHEELS GO ROUND

No. 2—The Cathode Ray Oscillograph

by H. C. W.

THE disadvantages of the electro-mechanical oscillograph are mainly associated with the mass of its moving parts because, although the wires of the suspension are very thin, they still have a natural resonant frequency somewhere between 1,000 and 4,000 cycles per second, and it is usual for the element to be immersed in oil in order to "damp" down the resonance and obtain an even response.

The maximum frequency to which this type of oscillograph will respond is about 10,000 cycles, and even at that frequency there is a considerable falling off in sensitivity. At still higher frequencies the movement of the mirror tends to churn up the oil surrounding it, which becomes cloudy, preventing the clear reflection of the light beam. At still higher frequencies the inertia of the wires and mirror is so great that no movement takes place at all.

The cathode ray oscillograph, on the other hand, is an instrument in which there are no mechanical moving parts at all. The moving part is a beam of electrons which is deflected by an electrostatic (or magnetic) field and because the electron stream has no appreciable inertia, this instrument may be used to observe frequencies as high as many millions of cycles per second.

It is not so convenient for obtaining photographic records as is the Duddell type of oscillograph, though tubes are available which will produce two separate traces at the same time. The construction is similar to the thermionic valve in that an electrically heated cathode is made to emit a stream of electrons. This stream is passed through an electrostatic field formed by the focusing electrodes ; it then passes between the deflecting plates, to which the wave-form to be observed is applied, and finally comes to a focal point at the surface of the viewing end of the tube. This end of the tube is called the screen, and is covered on the inside with a fluorescent powder which glows at the point where the electron stream impinges on it. The general construction is shown in Fig. 7a. For some special applications the fluorescent screen may be arranged to have an after-glow so that the image on the screen persists for a short period of time after the beam has passed.

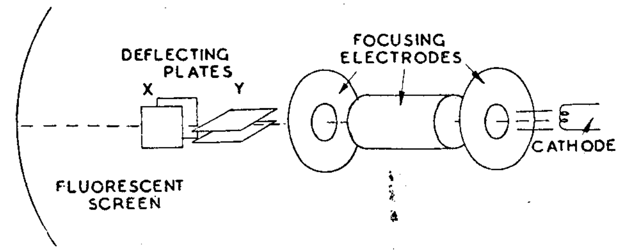


Fig. 7a

When opposite potentials are applied to one pair of deflecting plates, the beam is deflected towards the positive plate and away from the negative one. The bright spot on the screen will, therefore, move correspondingly. The plates deflecting vertically are termed the Y plates, and those deflecting horizontally the X plates.

It should be clear from the foregoing that with the tube functioning normally and no deflecting voltages, there will be a small bright spot in the centre of the screen. The correct potentials applied to the Y plates will cause the spot to move to the top of the screen, the amount of deflection being proportional to the voltage applied. If the potential is reversed, the spot will move to the bottom of the screen. An alternating potential will produce a vertical line as the spot swings up and down at the frequency applied.

To resolve this wave it will be necessary to apply to the X plates a potential that is changing from negative to positive, so that the spot will move from left to right at the same time as it is moving up and down. It will then trace out the wave of Fig. 8. This is not enough, however, since the spot will trace out the wave of Fig. 8 and vanish off the right-hand edge to the tube. What we want is for the potential of the X plates to fly back rapidly to where it started and increase as before ; and we want this to repeat itself over and over again, so that there will be a

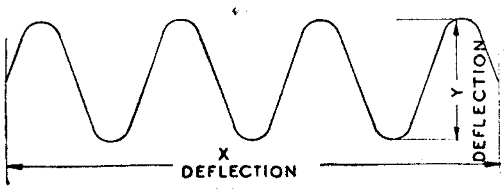


Fig. 8

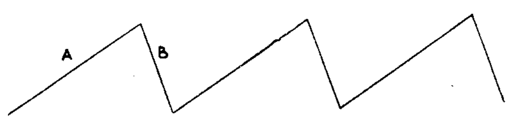


Fig. 9

**Continued from page* 780, *Vol.* 96, "*M.E.*," *June* 26, 1947.

series of waves one after the other. If we can, by choosing the speed at which the spot is moved along the X axis, make these waves coincide, so that the spot starts its travel from the left-hand side of the screen at the same point on the up and down movement of the spot in the Y direction each time, then the result, owing to the persistence of vision, will be a stationary picture. To obtain this result the frequency of the time base wave applied to the X plates will need to be a factor of the frequency of the wave applied to the Y plates.

Fig. 10

The wave-form of the time base is shown in Fig. 9 and from its shape it is called a "saw tooth" wave. The part (A) is where the potential is increasing from negative to positive and the part (B) is the "fly-back." For the best results the part (A) should be a straight line. If the part (A) is curved, as shown in Fig. 10, the resulting picture will be as shown in Fig. 11, where the sine wave is squeezed up on the right-hand side of the picture, though this may not be important for ordinary applications.

In Radar, where the cathode ray tube has been most used during the war, a short pulse signal is sent out by the transmitter when the spot is at the left-hand end of the screen and as the spot moves from left to right the radio wave travels out and is reflected back by any metallic object, such as an aeroplane. The returning signal is made to cause a deflection on the Y axis, and the distance of this from the origin along the X axis is a measure of the distance of the plane. See Fig. 12.

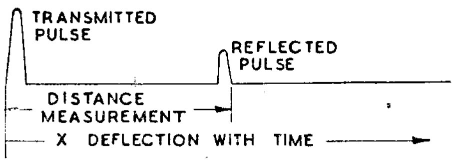


Fig. 12

The C.R.O. is finding increasing applications in mechanical engineering and one such application is the study of strain in moving parts, such, for instance, as an aeroplane propell r rotating at high speed. For th se purposes a fine wire is used securely sandwiched between two insulating sheets. It is called a strain gauge. It is securely attached to the part under test in such a way that it becomes a part of it and is stretched or compressed with the metal. The consequent variations of the resistance of the wire vary the current through it. The current variations are passed through a valve amplifier and applied to the C.R.O., where they appear as a picture on the screen. Thus it is possible to see exactly what stresses are set up in a piece of machinery while it is rotating at high speed.

In conjunction with a piece of apparatus for transforming changes in pressure into variations of electric current, the C.R.O. may be used

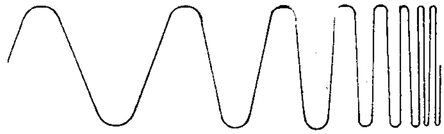


Fig. 11

for obtaining indicator diagrams of I.C. engines. Such a device might consist of a small diaphragm operated upon on one side by the cylinder pressure and acting to compress a series of carbon pellets supplied from a source of constant voltage. The resulting variations in current could be amplified and applied to the C.R.O. and the device have a minimum of moving parts.

In general, the most common application up to the present has been the electrical one in which the C.R.O. is used for examining the functions of electrical apparatus and, of course, for the television.

Unfortunately, the cathode ray tube is one of the things which cannot be made in the workshop, but quite a number of ex-Radar units are to be found amongst the Government surplus gear now on sale in the shops. Some of this, containing the tubes and associated gear is capable of being made up into very useful equipment for the home workshop.

Warning

It is necessary to sound a note of warning here, as this appar tus usually employs voltages within the apparatus which are dangerous to life. It cannot be emphasi ed too often that it is dangerous to operate this apparatus with the protecting covers removed.

(To be continued)

"Hielan' Lassie"

(*Continued from page* 39)

using a piece of rod $1\frac{1}{4}$ in. long for the body. After machining the valve part, reverse in chuck and turn down the bottom end to $\frac{1}{8}$ in. diameter for $\frac{1}{4}$ in. length, and screw $\frac{1}{8}$ in. or 5-B.A. The $\frac{3}{16}$ in. pipe for hose connection, is silver-soldered into the valve-body, at the same heat as the nipple. The valve is situated just ahead of the drag-beam, with the pipe passing through the right hand hole in the bracket (see drawing of drag-beam with brackets, in the last "Lassie" instalment) and supported by a little inverted angle-bracket screwed to the inside of the cradle; the screw under the valve-body passes through a hole in it and is nutted underneath. The union-nipple is connected to the cross, or double tee, as described above. Please yourselves how far the handle projects above the drag beam; about $1\frac{1}{2}$ in. would be a convenient height for operating, and wouldn't be in the way of the fireman's shovel.

MINIMISING BRAKE TROUBLE

L.M.S. Research Laboratories have developed a new instrument for detecting and measuring leakage in the automatic vacuum brake system of railway vehicles·

THE automatic vacuum brake system of a railway vehicle would be prohibitively difficult to maintain in perfect leak-tightness, and in practice the problem becomes that of restricting leakage to a small amount that can be dealt with by the auxiliary air ejector on the locomotive. It is the standard practice, of course, for vacuum brake systems to be tested before all new and repaired vehicles leave the main works. In service, however, it has not been possible, hitherto, to apply a scientific test at out-stations, and some convenient means of leakage testing was needed whereby vehicles could be checked periodically or as desired at any time, thus minimising the possibility of brakes failing in service with consequent delays to traffic.

For such purposes a simple portable instrument has been developed in the Research Laboratories of the London, Midland and Scottish Railway. It can be manipulated by one man, and shows at a glance whether the rate of leakage into the evacuated brake system is greater or less than a tolerable value. To achieve this object without the use of a clock or stop-watch, it was decided to adopt the principle of a slow, standard leak against which to compare the actual leakage into the brake system of the vehicle under test. Details of the apparatus in its original form are shown by Figs. 2 and 3.

The basis of the whole intrument is the standard leak. It takes the form of a length of capillary tubing, made of corrosion-resistant metal as used for hypodermic needles, through which air from the atmosphere slowly leaks into a small, evacuated cylinder incorporated in the apparatus. As the outcome of preliminary experiments, the bore of the capillary is of such a size that a convenient straight length of tube gives the desired standard leakage, arbitrarily fixed at 2 in. Hg. (from about 21 in. Hg. to 19 in. Hg.) in 1 min. The outer end of the capillary is soldered into a screwed brass plug, by which it is

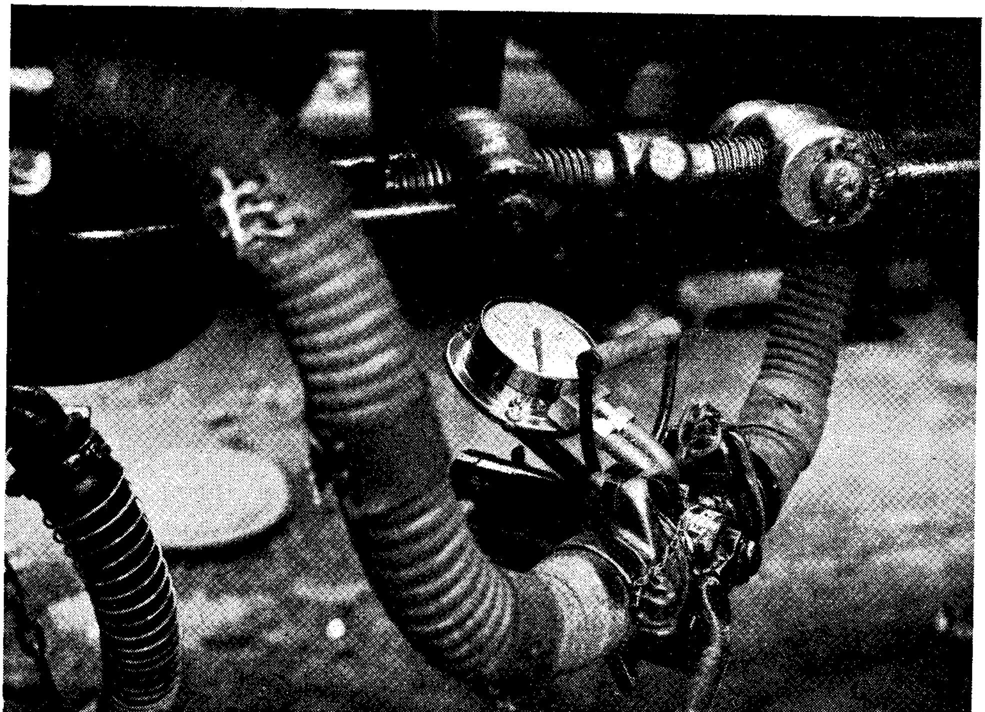


Fig. 1. Instrument for detecting and measuring leakage in the automatic vacuum brake system of railway vehicles. Photograph shows:—Routine inspection instrument of more compact design and lighter than the original apparatus (shown in Figs. 2 and 3) in position for test. Portion of train on the right of the picture is being tested

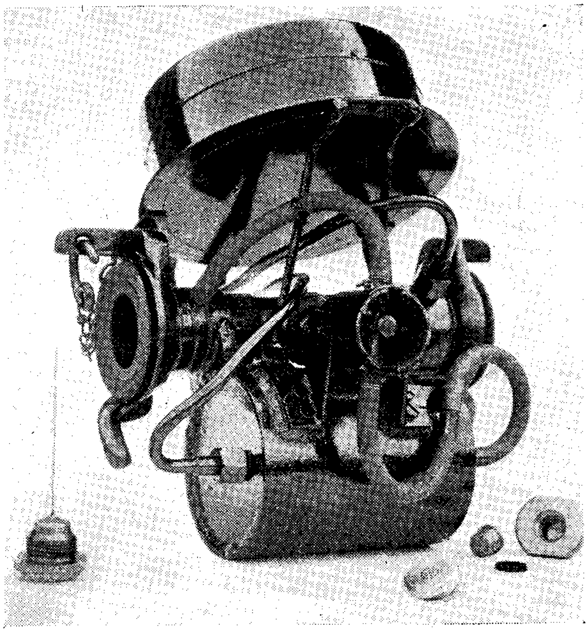


Fig. 2. Instrument for detecting and measuring leakage in the automatic vacuum brake system of railway vehicles. Photograph shows apparatus in its original form

sealed into one end of the cylindrical reservoir with the length of tube inside. A filter inside the plug, which is hollow, excludes dust from the air leaking in through the capillary. A valuable feature of the capillary tube is that its leakage rate can be readily calibrated by adjusting its length.

The actual and standard rates of leakage are indicated by means of a specially designed duplex vacuum gauge comprising two separate elements having concentric spindles carrying pointers moving over a single dial. This gauge is mounted, at a convenient angle, on a compact assembly consisting of two vacuum hose couplings with an interposed isolating cock, the spindle of which carried a separate cock whereby the reservoir fitted with the standard leak can be evacuated and subsequently isolated. One element of the duplex gauge is connected to the " leak reservoir " and has a red pointer ; the other element actuating a black pointer, is connected between the main isolating cock and one of the hose couplings (marked " train ") which is alway connected to the vehicle under test.

To make a test, the train pipe at one end of the vehicle is closed by its stopper, and the instrument is coupled between the other end and a source of vacuum, which may be an engine, with or without vehicles attached, or a separate mechanical evacuator, the operating handle is moved to a position (" create ") in which the same vacuum is created in the standard leak reservoir of the instrument as in the brake system of the vehicle under test. Both pointers of the duplex gauge move to indicate the same, maximum, vacuum. When this is attained, the operating handle is moved to the " test " position, separately isolating the leak reservoir and the brake system under test.

A refinement of the phase displacement of the two isolating cocks, or an appropriate method of using the instrument, ensures that immediately after the instrument is isolated from the evacuating source, the leak reservoir is left momentarily in communication with the system under test. By this precaution the reservoir and the system under test are brought to exactly the same vacuum before finally being separately isolated.

The red and black gauge pointers are thus originally coincident. As the vacuum falls, they move at different rates, showing at a glance whether the brake system is leaking at more or less than the permissible rate. The actual rate of either leakage can, of course, be readily timed with a stop-watch ;

(*Continued on page* 45)

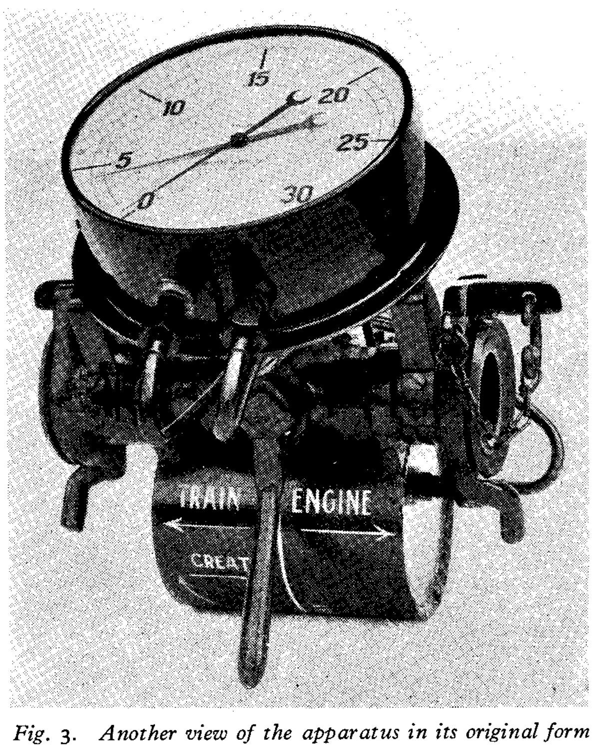


Fig. 3. Another view of the apparatus in its original form

MODELS AT THE B.I.F.

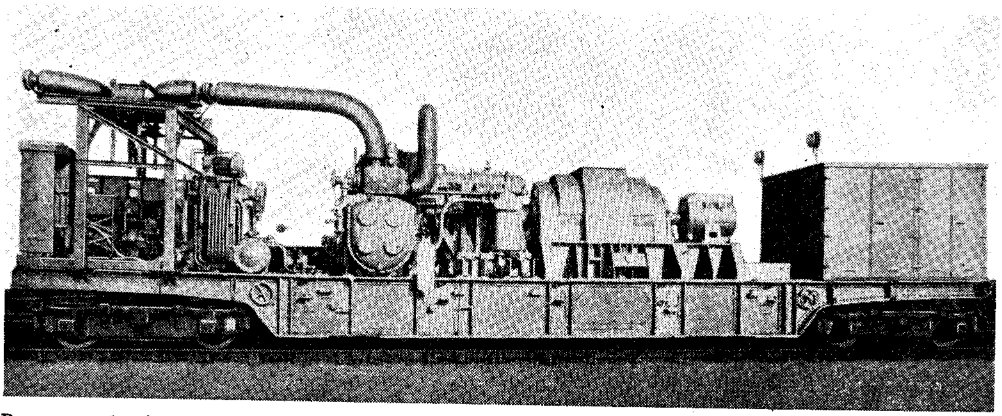
by C. G. Bainbridge

TO a model engineer, one of the most interesting features of the first post war B.I.F. at Birmingham was the extensive use made of models in order to demonstrate processes or special equipment and to depict some of the larger types of product which would be too large to exhibit. Most of these models were excellent examples of craftsmanship, some made by the exhibiting firms themselves, others by professional model-making firms. From the examples mentioned here it will be appreciated that apart from its technical value, the model has considerable possibilities for display and publicity purposes.

Demonstrational Models

A good example of the demonstrational type of model was provided by two exhibits of Messrs. Standard Telephones and Cables, Ltd. The one which attracted most attention was a complete "OO" gauge layout with station, goods sidings, coaling stage, etc., operating on 12-volt D.C. and made by Messrs. Hamblings; this model was intended for demonstrating the use of the firm's sequence switch interlocking, and panel control system for full size railway signalling apparatus. The other model, which was designed and made by the Company's staff, showed a portion of a housing estate complete with roads, houses, flats, garage, shops and cinema, to approx. 4 mm. scale and was used to demonstrate the "Standard" system of D.C. Bias control for street lighting. Incidentally, the street lamps on this model employed miniature surgical lamp bulbs (supplied by Rimmer Bros. of Clerkenwell) which were cast into position in the die-cast lamp standards.

Amongst other working models, which are in fact, really small machines, in that they are capable of actual production, should be mentioned the one-eighth scale chain making, spot welding, and rivet heating machines on the stand of Messrs. Holden and Hunt, specialists in this class of—full size—equipment. The Electric Furnace Co. were also showing a working miniature continuous plating plant, as well as other non-working models of various types of electric furnace.



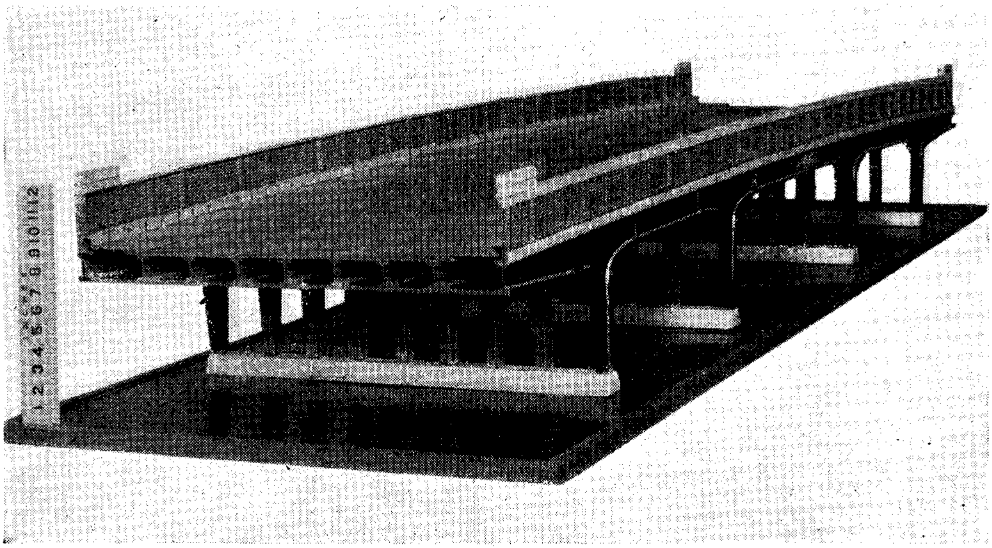
Power truck of a 2,500 kW mobile power plant for U.S.S.R.—A portion of one of the Metropolitan-Vickers rail truck mounted oil-fired power stations. The complete mobile unit consists of three trucks carrying boilers and auxiliary units, turbines and generators and switchgear

Amongst the non-working engineering scale models, Messrs. Metropolitan-Vickers exhibited a model, made by Stewart-Reidpath, of one of their truck mounted oil-fired power stations; several of the full-size sets have been supplied to the U.S.S.R.

Messrs. Vickers Armstrong showed two very fine professional ship models, each about 12 ft. long, one of H.M.S. *King George V*, the other of the liner *Strathmore*. These models reminded one of boyhood days with one's nose pressed against the windows of the shipping companies in Cockspur Street!

Display Models

There were also many architectural or display type of models; an old favourite is that showing the Port of Bristol with the Avonmouth Docks and Docks Estate; we are glad to see that this model has survived the war, it never fails to attract the public, partly on account of its size—it is about 20 ft. square—but also because of the excellent aerial view effect it gives of this extensive dock system. Similar, but mostly smaller models were exhibited by The Port of London Authority, and other ports and industrial



A 1/30th scale model of the all-steel, all-welded highway bridge at Billingham Beck, Middlesbrough, made by Mr. F. Hotchkiss, of Messrs. Quasi-Arc Ltd. A remarkable example of distortion-free light gauge welding

undertakings. Incidentally, the P.L.A. also showed a very large non-working model (made by A. D. Services Ltd.) of their 150-ton lift floating crane "Mammoth," which operates in the Royal Albert Docks.

Messrs. Babcock & Wilcox showed several showcase models of their power station type boilers.

As a means of showing methods of construction of large structures, models have a very much more effective publicity and instructional value than photographs or drawings. For example, the Oxley Engineering Co. exhibited a large working model of one of their two lift spiral guided, all welded, gas holders, several transparent panels being provided in the shell to enable the internal construction to be seen. Messrs. Quasi-Arc Ltd., makers of welding equipment, exhibited a model of an all welded highway bridge which spans the L.N.E.R. at Middlesbrough. The model, like the original, is made of shaped steel plates arc-welded together; 14-gauge steel was used throughout and the model was made to 1/30th scale, occupying six months of the spare time of Mr. F. Hotchkiss, one of the firm's leading welding experts.

Panoramic showcase models were shown by Messrs. Stewarts & Lloyds in order to illustrate the various uses of steel tubes; the Research Institute also displayed two similar models intended to demonstrate the increased rust resistance of steel structures when coated with various thicknesses of zinc, and when painted on tinned surfaces, an artificial rain supply being "laid on" into the showcase for this purpose.

Minimising Brake Trouble

(*Continued from page* 43)

and an occasional check of this sort is desirable to confirm that the standard leak rate is being maintained. The filter, of compressed cotton-wool, and the capillary tube are both easily renewable.

The original experimental apparatus, weighing 35 lb., was undesirably heavy for use as a routine inspection instrument, and a later, more compact, model in which the weight has been reduced to 16 lb. is shown in use by Fig. 1, where the portion of the train on the right of the picture is under test.

This instrument was devised by Mr. J. O. Cowburn, B.Sc., formerly of the engineering section of the London, Midland and Scottish Railway Research Department, who was recently awarded the Company's "Herbert Jackson" prize for this particular piece of work.

THE BATTLE OF MARINE PROPULSION

STEAM *versus* I.C. ENGINES

FOLLOWING the recent little argument in " Smoke Rings " about the incursion of the internal combustion engine into the realm of steam at sea, we have received some very interesting comments from Lieut.-Colonel A. G. Bates, who is fortunately placed for having inside knowledge of the subject from the ship-owner's point of view.

Here are the points he makes which we think put the case for the respective contestants very clearly and concisely, and incidentally, bear out the case for steam as advocated so forcibly by our original correspondent, Mr. Edwards.

Lieut.-Colonel Bates writes :—

(*a*) While it is true that the disappearance of coal as a possible fuel for ocean-going ships has focused attention on I.C., the main dispositions in this battle were made years before.

(*b*) *There is no battle* where power of 15,000 s.h.p. and above is concerned. In this field steam has it all its own way with few exceptions.

(*c*) Below 2,000 s.h.p. circumstances favour I.C.

(*d*) At about 3,500 s.h.p. the single-screw diesel is in a strong position and is ousting steam. The Doxford engine of this size is being made in ever-increasing numbers.

(*e*) From 7,000 s.h.p. to 10,000 s.h.p. *today* steam is winning, largely because the modern steam turbine, single-screw, machinery of these powers—

- (i) is lighter ;
- (ii) goes into smaller space ;
- (iii) costs far less in maintenance ;
- (iv) (on most routes) costs no more for fuel ;
- (v) involves no greater capital cost.

(*f*) In many people's opinion, 7,000 s.h.p. through a single screw is the top limit for diesel. Beyond this size cylinders are too big for trouble-free running. In consequence you will not find many I.C. ships of 7,000 s.h.p. or above which are not twin-screw. Twin-screw loses up to 10 per cent. efficiency compared with single, and the capital and maintenance costs go up steeply.

(*g*) The next development of steam afloat is likely to be a *uni-directional turbine* on power-station lines, geared double-reduction for ahead running and single-reduction astern, so getting reversal of motion. The most favoured arrangement involves two alternative hydraulic couplings—one for ahead and the other for astern running. This should give a fuel efficiency of about 0.48 lb. of fuel oil for s.h.p./hour. Parity of fuel costs with a good diesel is about 0.60 lb. of oil per s.h.p./hour.

(*h*) The gas-turbine folk are aiming at 0.40 lb., but there are a good many obstacles to overcome yet.

(*i*) Any form of electric transmission (turbo-electric or diesel-electric) still involves not less than 8 per cent. loss compared to mechanical until you get to 50,000 s.h.p. and above, when it comes down to 4 per cent.

(*j*) Electric transmissions = prohibitive capital cost.

I admit steam at 500 lb. and 800 deg. F. has a lot of traps for the unwary. A tiny leak cannot be seen, but eats away the metal of a joint-face in an amazing way !

The generalisation—" Steam for the big ones ; I.C. for the small fry "—*is* completely true for the top and bottom ends of the scale, but in the middle range you may often find ships of *identical* powers in *different* trades which are firm advocates of one or the other method of propulsion and *each will be right.*

To take one example—the N.Z. and Australian refrigerator trade to the U.K.—why is this almost 100 per cent. diesel ? As is so often the case, there is no one answer but a whole collection of them, out of which I could pick the following :—

(1) The Australian liner trade, is and always has been, by custom a *twin-screw trade.* This is now somewhat illogical, but it persists and permits the use of a pair of diesel units each of which is not unduly big for good maintenance.

(2) The *long hauls* make bunkering problems easier for the comparatively low diesel-oil consumption than for the steamer.

(3) Cheap diesel-oil supplies in the Panama Canal zone.

A Concluding Item

One final point which you may find intriguing : There are many steamers being built today which for *over half their life will have no steam* ! Mostly they are water-tube boilered turbine jobs, which use steam *only to propel* and electricity *diesel-generated* for *everything else*, including all engine-room auxiliaries, galleys, winches, windlass, etc. Even the boiler feed-water is pushed into the boilers electrically ! Thus you may have 8,000 s.h.p., say, developed in your turbines with steam at 450 lb. and 750 deg. F. and everything else in the ship diesel, needing some 250 kW. In port you shut down your boilers and the ship's life is diesel/electric—hence the paradox, since on some routes a 15-knot ship must spend more time in port than at sea.

The system works well, but despite the fact that we get our bath-water kept hot by the heat of the exhausts of the diesels, it irks my economic soul that no way can be found for letting unused potential kWs help to push the ship along ! The relative consumption of the two fuels at sea are roughly 45 tons boiler-oil and $1\frac{1}{2}$ tons diesel-oil a day, and for that small quantity the ship (and her crew) get many benefits.

BALL-BEARINGS and the MODEL ENGINEER

by "Don"

DUE to the relatively small size of the average model, the power output is correspondingly small and it therefore behoves the engineer to eradicate as far as possible, those features which sap this power before any useful work is done. Probably the worst of these are the bearings and when one considers that the coefficient of friction for an ordinary plain bearing is 0.010, and that of the ball-bearing is 0.001, it is surprising that more use is not made by the model engineer of these high-precision units.

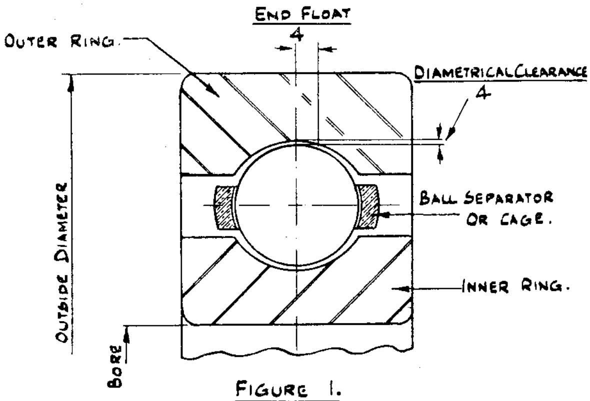


FIGURE 1.

Perhaps this is because the so-called "frictionless" bearings require rather more care in fitting or else the average model engineer is a little dubious as to the merits and application of the varieties available. Whatever the reason, however, the purpose of this article is to describe, as non-technically as possible, the functions and application of the more common standard types.

Fig. 1 shows the normal single row ball journal bearing to an enlarged scale, with descriptive notations and a study of this will clarify much of the following text. The internal details have been exaggerated purposely, and the illustration should be treated as a diagram only.

All ball-bearings are supplied with some degree of internal slackness, the amount depending on the type, size and application. If the standard single row ball journal bearing is examined closely, 1, 2 or 3 small etched circles will be found adjacent to the stamping on the inner ring. These are the indication of the fit (or internal slackness); "0" indicates the least amount, or tightest fit, "000" the greatest amount of slackest fit. This is usually measured in terms of "axial play" or "end float" and is 0.0015 in. for "0" fit, and 0.005 in. for "000" fit. These figures are only an approximation and apply to bearings of 1-in. bore and under. Also present is a small amount of radial clearance sometimes known as "diametrical clearance"; this varies from 0.0002 in. for "0" fit and 0.001 in. for "000" fit, these figures again being approximate and applying to the smaller sizes. A further glance at Fig. 1 will show these points much clearer.

Basic Types

Figs. 2a and 2b illustrate the standard single row ball journal bearing, probably the most widely used of all the basic types. It is available in light, light narrow, medium or heavy construction and a size can usually be selected from these which will deal with any combination of loads and speeds. Since the model engineer is invariably restricted to small diameters, and loads and speeds are not normally of a high order, attention will be confined to the light and light narrow series. The light series (Fig. 2a) is supplied in both metric and English sizes. The smallest metric listed by most of the manufacturers is 6 mm. × 19 mm. × 6 mm., and the smallest English ($\frac{1}{2}$ in. × $1\frac{5}{16}$ in. × $\frac{3}{8}$ in.). If at all possible, the millimetre sizes should be used, as not only can they be obtained smaller than the inch bearings, but they also show an advantage as regards section, i.e., the ratio bore to outside diameter is smaller, thus saving a little of that valuable commodity, space.

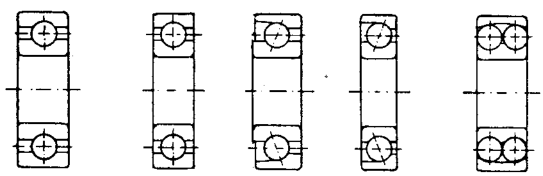


FIG 2a FIG 2b FIG 3 FIG 4 FIG 5
CAGES OMITTED FOR CLARITY.

Fig. 2b illustrates the light narrow series, and these are of similar construction to the light. They are, as a general rule, slightly smaller in section, bore to outside diameter, and are also narrower. Here again, metric and English sizes are available, millimetre from (10 mm. × 32 mm. × 9 mm.), inch from ($\frac{1}{4}$ in. × $\frac{3}{4}$ in. × 7/32 in.).

Both of the above series may be used for journal loads, i.e., those acting on the bearing at right-angles to the shaft or for thrust loads which act parallel to the shaft. They will also deal with any combination of these up to the full rated capacity of the bearing.

Fig. 3 shows the standard single row double purpose bearing, which, as the name suggests, is specially designed for taking journal loads

and also thrust loads in one direction only. The outer ball track is ground offset from the vertical centre-line, and the ball is therefore made to contact at approximately 20 degrees from this line. Actually, this type of bearing is now superseding the flat washer type of thrust bearing on many applications, particularly where the speeds are high. As previously stated, it is

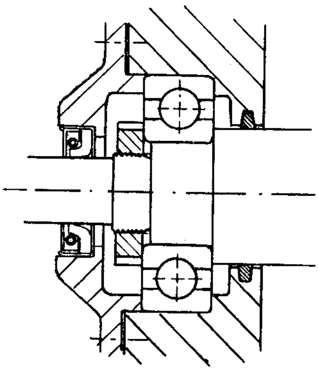


FIGURE 6

only suitable for thrust loads in one direction, and it is usual to fit two bearings mounted opposite to each other, i.e., one bearing to deal with the load in one direction, the other in the opposite direction. They should be very carefully adjusted laterally so that they are not unduly stressed by over-adjustment and equally that there is no excessive end float in the assembly.

Fig. 4 shows the magneto type bearing, which is similar in construction to the single row double purpose bearing (Fig. 3). They are, in general, of lighter section than the latter and also differ in the fact that the outer ring is detachable and the components are interchangeable.

Fig. 5. Here is shown the double row self-aligning ball journal bearing and a study of the outer ball track will show that this is in the form of a portion of a sphere. This allows the bearing to be self-aligning, a very important feature in those cases where perfect alignment of housing bores cannot be guaranteed, such as line-shafting, etc. Unfortunately, however, though it may be used for location duties, it is not suitable for anything but the lightest of thrust loads, since under the action of these loads, one row of balls is unloaded and consequently ball spin and ultimate failure result.

This by no means exhaust the types of ball-bearings available, but does cover those in every-day use.

Lubrication

Ball-bearings are precision units and are manufactured to extremely small limits of inaccuracy, therefore correct lubrication is essential if efficient service is to be obtained. The ideal lubricant is oil, preferably pure mineral oil. It sometimes happens, however, that other parts of the machine (gears, etc.) are required to be lubricated by the same oil, in cases such as this, care should be taken that an oil with a corrosive action is not selected. If at all possible, the bearings should be isolated and lubricated by an oil bath. The oil should be maintained at approximately the centre of the lowest ball.

Fitting

When fitting ball-bearings, the following points are of paramount importance.

Cleanliness is absolutely vital for the successful working of the rolling elements and the smallest piece of hard matter, be it metallic or silicous, can do untold damage. At the best it will cause the bearing to run roughly or with a knock, and at the worst, will be rolled into the ball tracks, causing the surface to break up, eventually leading to complete failure.

The shaft and housing bore should be to as fine a finish as possible, and abutment shoulders should be square with the bearing seats.

Most model engineers are familiar with the term "piston fit," and the bearing should be just this, in or on the stationary member. On the revolving member, however, a light press fit should be adopted, whilst additionally, the bearing should be locked axially by a nut or other means. Sometimes it is impossible to do the latter, due to space considerations, etc., in this case, a slightly heavier fit is permissible, but care must be taken, that this is not too tight, or the very small amount of diametrical clearance initially present in the bearing will be absorbed due to expansion, the bearing running with a pronounced whine, eventually failing.

Bearing Protection in Service

As cleanliness is essential in fitting ball-bearings, so the continued protection of them in service

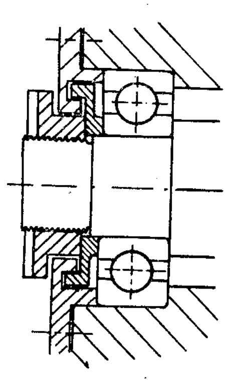


FIGURE 7

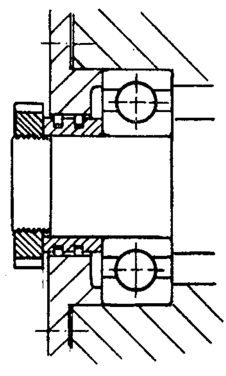


FIGURE 8.

is also of extreme importance. For this purpose, there are a number of excellent devices available, all of varying degrees of efficiency. Probably the most widely used of these is felt or similar packing, and as there is always rubbing contact between the bore of the seal and the shaft, it should be soaked in tallow and well oiled before fitting.

Proprietary seals, usually consisting of spring-loaded leather cones, can be obtained to suit all sizes of shafts; these should be fitted to the

instructions issued by the manufacturer. They are suitable for those conditions where the bearings are working in exceptionally dirty surroundings, and Fig. 6 shows a typical arrangement of one of these used in conjunction with a felt washer. Both of these seals have one minor drawback, in the fact that they rub on the shaft, tending, of course, to absorb power.

A very efficient mechanical seal is that shown at Fig. 7. This is known as the labyrinth type,

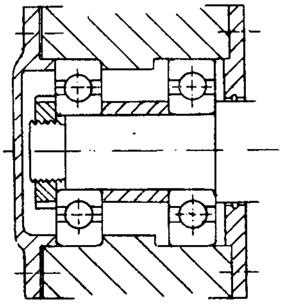


FIG. 9 a

and there should be approximately 0.005 in. clearance, radially, between the revolving and stationary members. This form of seal, is most efficient at high speed, as in the lower speed range, foreign matter is liable to creep into the bearing housing, unless the labyrinth is made really elaborate.

A compaiatively recent development in sealing technique is that known as the "piston ring seal." In consists of one or more standard commercial rings, fitted exactly as if they were being used for their designed purpose. Extensive tests have shown that the power absorbed by this method is negligible and altogether it is a very simple efficient seal. Fig. 8 shows a typical arrangement.

When using two-ball journal bearings, the accepted practice is to use one as a location unit, the other being allowed to "float" or in other words, is not locked axially in the housing. This ensures that the bearings are not over-adjusted, there being end-float in the assembly, equal to that present in the location bearing. This is shown at Fig. 9a. A variation of this scheme is shown at Fig. 9b. Here the inner rings of both bearings are locked endwise on the shaft, and by careful adjustment of the screwed end caps, the outer rings are moved inwards until all end-float is removed from the assembly.

Fig. 10 shows a simple arrangement of either double purpose or magneto type bearings for a small milling or grinding head, this being suitable for mounting on the cross-slide of the average small lathe. Above the centre-line, the bearings are mounted face to face and the end caps are screwed down until all axial play is eliminated, great care being taken not to over-adjust. Below the centre-line, the bearings are mounted back

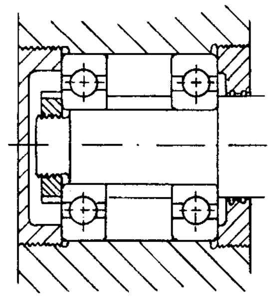


FIG 9 b

to back, adjustment being effected by screwing down the nuts on the shaft, the same precautions against over-adjustment being necessary. Of the two, the lower arrangement is probably the more rigid, but is also a little more difficult to construct.

A small revolving centre, to suit a No. 0 Morse taper, is shown at Fig. 11. The bearing fitted, a special of the double row double purpose type, ($\frac{3}{8}$ in. × $\frac{7}{8}$ in. × $\frac{5}{8}$ in.) was produced in fairly large quantities during the war and consequently, the reader may be lucky enough to obtain one of these, though *not* from the bearing manufacturers, as production of these was suspended at the cessation of hostilities. The centre, makes a very useful addition to the small lathe.

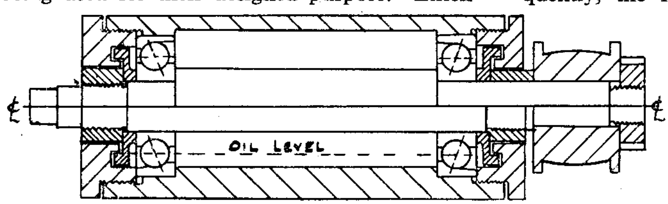


FIG 10.

Finally, the writer would stress the fact that the chances of obtaining new bearings, particularly the smaller sizes, are fairly remote, since the manufacturers, in common with the rest of the country, are working flat out to supply industry, impoverished by seven years of war, and output is allocated for many months ahead. There should be, however, any number of only part-worn bearings around the country, with quite a lot of useful life still in them; these may be used, provided of course, they are in good condition.

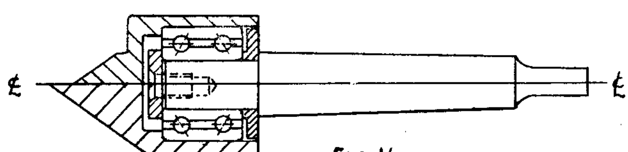


FIG 11.

MANDREL AND BACK GEAR

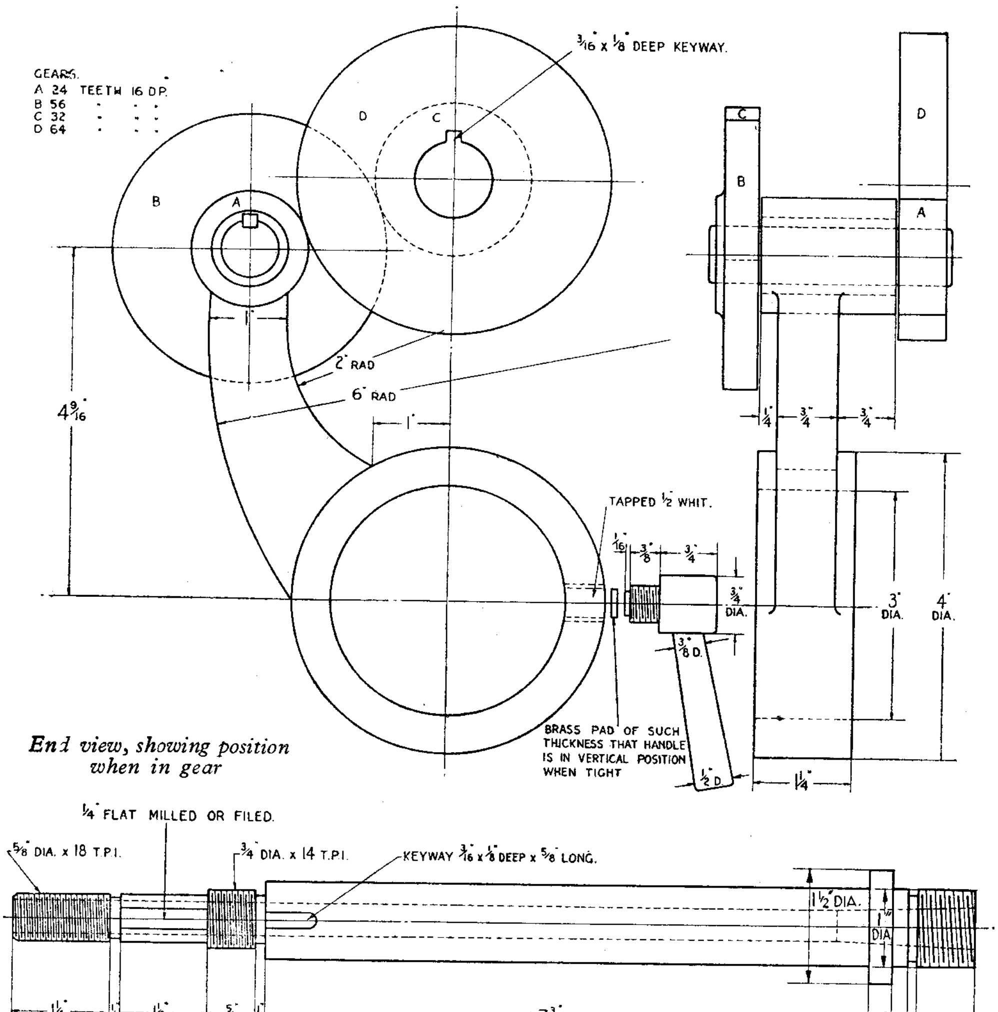
FOR THE ROUND BED DRUMMOND LATHE

by B. Cartwright

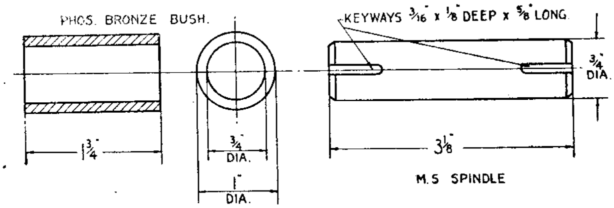
THE mandrel consists of part of a lorry back axle ; this was first annealed, then a length sawn off long enough to face ends when finished, and turned and screw-cut as per drawing. As the lorry axle was some two and a half inches in diameter one can realise that this was a tedious task ; however, it was accomplished by the aid of a friend's lathe and a one-third horse-power motor (which pretty nearly gave up the ghost under the strain !).

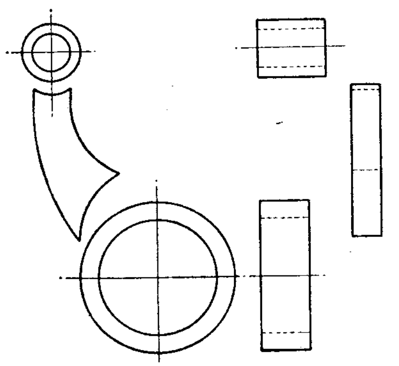
As will be seen, the mandrel is long enough to fit a ball thrust washer between the collar and front bearing, and a fibre washer in between gear D, which is keyed to mandrel, and rear bearing.

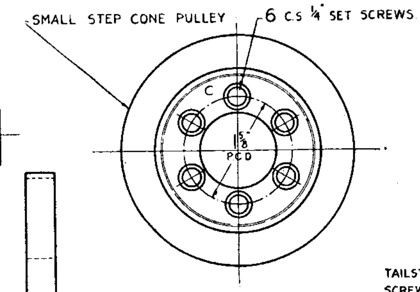
The back gear bracket consists of three parts, as seen in the exploded view. The main thing to watch is the assembly ; see that the large collar or ring is bored a good fit for the end of the bed that projects through the headstock, and that the bores of the collar and back gear



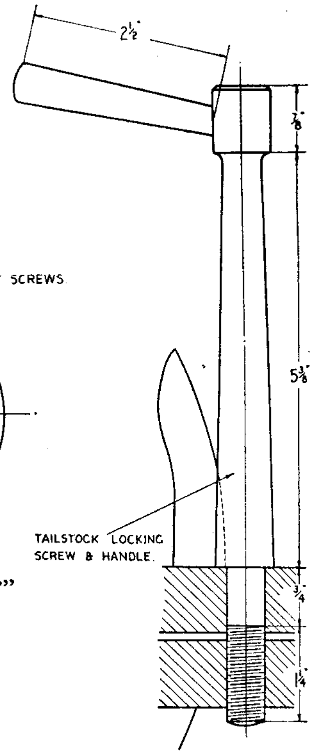
End view, showing position when in gear







Method of fixing gear "C" to cone pulley



Exploded view of parts of back gear bracket

spindle bearing are parallel. The parts can either be welded or brazed, a simple job for locomotive boiler makers; or if anyone wishes, why not make a pattern and have a bracket cast at the local foundry?

The gears specified are the ones in use on my own back gear, and these give a ratio of 6.25 to 1, but any other gears can be used, so long as the two pairs of mating gears have the same distance between centres. It will also be seen from the drawing that a smaller gear than the one specified for fixing to the cone pulley is not practical, unless smaller screws are used. The other parts, such as the phosphor bronze bush, and back gear spindle, need no further description other than that on the drawing.

On most inexpensive lathes (and not a few expensive ones too) everything that wants tightening up or locking needs a different sized spanner. The drawing of the tailstock locking screw will show how I avoided the need for a spanner on my lathe; half a turn of the hand lever only being necessary to lock the tailstock in any desired position.

War Surplus Instruments

MANY of our readers have enquired of us regarding the availability of war surplus material, such as aircraft and other instruments, which have many uses and applications in model engineering. We are informed by Messrs. Aero Spares Ltd., 69, Church Street, Edgware Road, that they have a very large and wide variety of instruments of all kinds for disposal, and samples have been submitted for our inspection.

In addition to the usual range of aircraft navigation instruments, such as pressure and vacuum gauges of all kinds, engine speed indicators, altimeters, airspeeds, and radiator thermometers, they offer a wide range of motors as used for all sorts of aircraft duties, including de-icing gear, radio valve cooling, cameras, etc., and several types of motor generators and rotary converters, control rheostats and high-class electrical measuring instruments. Sextants, magnetic and gyro-compasses are also available.

An item of interest to draughtsmen is an aircraft course plotter, which could quite easily be converted to an efficient draughting machine. The possibilities of adapting aircraft tachometer flexible drives and gearboxes to workshop purposes will also be apparent to our readers.

Among the more complex instruments are complete aircraft cameras, with high-class lenses and motor-driven shutters and film-winding mechanisms; also aircraft position indicators, instruments of amazing ingenuity, which integrate compass readings, drift, airspeed, etc., automatically; and gyro-controlled automatic pilots. Many of these instruments are unused, but in all cases they are offered at prices which represent only a fraction of their original value, and substantially less than that of individual components which can be obtained on dismantling them.

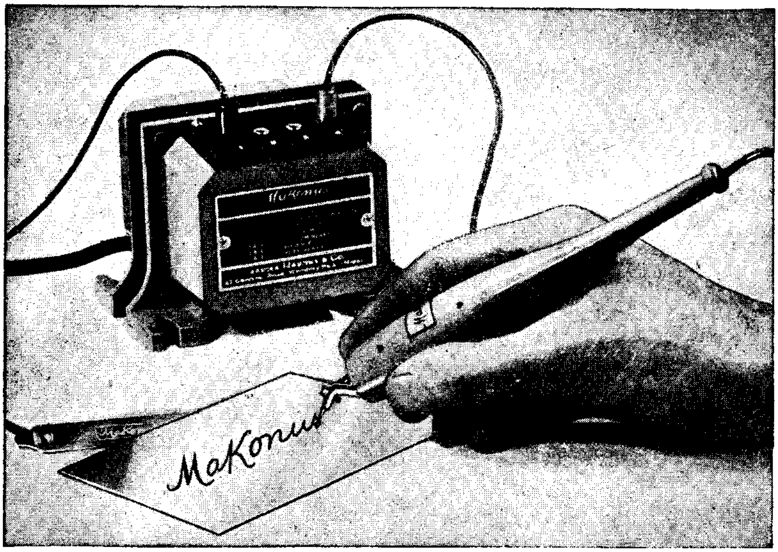
THE "MAKONUS" ELECTRIC PENCIL

AMONG the many items of interest on the stand of Messrs. E. H. Jones Ltd., at the Birmingham section of the British Industries Fair, was a large sheet of metal on which were inscribed the autographs of many visitors to the stand. This unique "visitors' book" was made possible by the aid of a small and relatively inexpensive marking appliance which has a wide range of practical application in any workshop.

The device consists of a writing instrument not much larger or heavier than an ordinary pen, the holder of which contains an electro-magnet, having an armature or vibrator, to which the marking stylus is attached. The latter thus forms a contact point, making a circuit through the metal object to be marked, when brought in contact with it. By the excitation of the electro-magnet, the armature is attracted, and causes the stylus to be lifted from the surface of the metal, thereby breaking the circuit and setting up a vibratory cycle, as in an electric bell or buzzer. Each time contact is broken, a minute arc is formed at the point of break, pitting the metal slightly and leaving a permanent and indelible mark; the contact pressure necessary to produce the rapid vibration is adjusted by touch, and it is thus possible to write on the metal just as easily as writing with a pen or pencil on paper.

The stylus is made of material highly resistant to heat and corrosion, but it is readily renewable when worn by simply loosening the fixing screw.

The depth of impression can be controlled by regulating the amount of current supplied to the instrument, the source of supply being normally a small tapped transformer connected to the electric mains, though a battery may be used if desired.



The Makonus Electric Pencil in use

This method of marking offers many advantages over most other methods available in the small shop. Engraving calls either for expensive machine equipment or for specialised skill; stamping may cause distortion of work, and is quite impracticable for either very hard or fragile articles; while etching is generally a messy business, involving the use of chemicals which are best kept well away from the engineering workshop. The "Makonus" pencil can be used on any metal, and will mark hardened steel just as effectively as softer material. It obviously cannot be used on non-conducting materials, such as plastics, glass, china, etc.

In passing, it may be mentioned that Messrs. E. H. Jones Ltd., have recently opened a new showroom at 72-78, Wrentham Street, Birmingham, and on a recent visit to this establishment we saw, in addition to the usual range of large industrial machine tools and equipment, many items of interest to the user of a small workshop, including watchmaking lathes and accessories, precision boring heads, micrometers and other measuring instruments, and small tools.

Editor's Correspondence

Small Drilling Machines

DEAR SIR,—I think I am right in saying that small hand bench drilling machines are now no longer obtainable. They could be bought before the war, but they were mostly foreign and, if the one I have is a fair specimen of its type, they were very far from being precision machines. Mine runs so far out of truth that it bends and snaps $\frac{1}{16}$-in. drills, and the use of smaller drills is out of the question.

Such a machine is useless for any fine or accurate work, but I should welcome the appearance of a hand bench drilling machine built for small work on precision lines. There are plenty of small power-driven drilling machines for sale, but the cost of such an outfit (with motor) is about £14, nor are motors always available, nor has everyone got electric power. I believe that a machine such as I have described would be most useful in a modest workshop, or to a man of moderate means. But, I would add, it should be restricted to the use of small drills ; a machine of this type made for drills up to and including $\frac{1}{4}$ in. is apt to be an unsatisfactory compromise, because it is built up to heavier and coarser standards than are suitable for the small model maker.

Yours faithfully,

Kensington, W.8. R. A. POWELL.

Dome Positions

DEAR SIR,—In a recently published letter to your journal, I remarked, in perfectly good faith, that *in my opinion*, to which, presumably, I am entitled, the domes on Stroudley's engines were, from the aesthetic point of view, too far back.

This has called forth an explanation for the reasons for its position, together with a suggestion that if it had been placed on the next ring, it would probably have been criticised as being too far forward. It would certainly not have been by me.

I was perfectly familiar with the construction of the "Gladstone" boilers when I wrote, as I had a drawing of them beside me (as I have now). I still believe that the dome would have been just as effective if placed at the rear end of the middle ring of the boiler barrel, which would have brought it some 3 ft. 6 in. forward and would, *in my personal opinion*, have improved the appearance of the engines.

This position was the usual one in contemporary engines.

Ignorant, as your contributor hints, I may be, but not sufficiently to lead me to believe that Stroudley or any of his equally capable contemporaries would mount a dome over a circumferential joint ring, and the suggestion that I am unfamiliar with the construction of locomotives is untrue.

I commented again on the appearance of Stroudley's and Johnson's cabs, and again I was careful to point out that the former were probably the more comfortable. Reference to my letter which appeared in THE MODEL ENGINEER on April 10th, will show that I neither said nor implied that Johnson's cabs would have improved Stroudley's engines ; that suggestion emanated from your contributor.

Injectors

For the first 25 years of my working life I was intimately and practically concerned with steam engines and boilers (including locomotives) in my daily work ; in all that time I never came across an injector that *delivered* cold water ; it would be interesting to have particulars of these unusual accessories, most of the injectors with which I was familiar would, with a cold feed supply of, say, 55 deg. to 60 deg. F., deliver at a temperature considerably in excess of 150 deg. F., not exactly "cold." Considering that the functioning of an injector involves the condensation of the steam operating it and that the heat given out in this process, including the latent heat of condensation, is to a very large extent absorbed by the feed water, it is in the nature of things impossible for any normal type of injector to deliver cold feed, unless, of course, the feed be deliberately cooled after leaving the delivery cone ; just as nobody would have expected Stroudley, in your correspondent's humorous phrase, to be such a Billy Muggins as to mount a dome on a circumferential joint, so equally I imagine nobody would expect his successor to be such a Billy Muggins as to deliberately cool his injector delivery.

Your contributor, in describing his personal investigations, implies that a modern youth under similar circumstances, would have his boss "fly off the deep end."

One of my major responsibilities is the organisation and supervision of the training of engineering apprentices, and this naturally brings me in contact with other people with similar responsibilities all over the country.

Without any question at all, the boy with an enquiring mind today receives far more encouragement and help in every quarter than did the similarly enquiring youth of forty or fifty years ago.

The trouble lies, not in the discouragement of enquiring minds, but in the comparative paucity of enquiring minds to encourage.

Yours faithfully,

Harrow. K. N. HARRIS.